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WHENCE CAME THE CULTIVATED STRAWBERRY?

BY L. H. BAILEY.[1]

The strawberry has been extensively cultivated only during the last century, and the earliest attempt at methodical amelioration extends back little more than two hundred years. The first horticultural variety of which we have any account is the Fressant, which dates from 1660. The wild species of strawberries are few, not numbering more than a dozen under the most liberal estimate, and they are well represented in the great herbaria or botanical centers of the world. Only a part of the wild types have been impressed into cultivation, and exact or very approximates dates can be given for the introduction of these cultivated species.

The strawberry, therefore, is a modern fruit, and its history and evolution would seem to possess no difficulties; and yet, despite all these facts, the botanical origin of the cultivated varieties is unknown, and we have the anomaly of a common fruit, appearing within little more than a century, which the botanist does not refer to any species. Here, then, is a most remarkable instance of the evolution of a new type of plant, taking place under our very eyes: whilst the botanists have written precise histories of its successive progresses, the reasons and methods of its development have escaped them. Perhaps there is no other plant which has so quickly obscured its own

[1]Lecture before the Author's class in Horticulture, Cornell Univ., Ithaca, New York.

origin, or in which the speculative evolutionist can find stronger proof of the instability and elasticity of plants.

I have said that the history of the strawberry is well known. There has been a careful record from the time Casper Bauhin and his contemporaries wrote their voluminous herbals. We cannot expect, as this time, therefore, to add anything to this long and consequential record. We must accept the history essentially as we find it. But it is possible that we shall be able to elucidate the evolution of the strawberry by the application of some of the principles of plant variation, the knowledge of which is now sufficient to warrant a constructive retrospect. At all events, if these laws cannot solve the general problem of the evolution of the strawberry, we must continue to remain in ignorance of its birth and departure. This inquiry will be all the more interesting, also, from the fact that the first monographer of the strawberries, Duchesne, in 1766, made an attempt to explain the origin of known species from the Alpine or Everbearing strawberries of Europe, and this essay, which has apparently not attracted the attention of modern philosophers, is one of the earliest efforts to account for the origin of organisms by means of a course of development.

It is necessary at the outset to eliminate the so-called European types of strawberries from our inquiry. These belong to three or four species native to Europe, chiefly to *Fragaria vesca* and *F. moschata* (*F. elatior*), and the botanical characters are sufficiently clear and uniform to allow of little doubt as to their origin. The first strawberries, like the Fressant, are of this type. These European types are mostly small and delicate fruits which are grown in France and some other parts of continental Europe, but which are little more than curiosities in England and America. It is the class of large American and English strawberries to which I now wish to direct attention, a type which, while grown in all temperate countries, seems to have first come to great prominence in England and which is the only market strawberry of America.

The first foreign strawberry to reach Europe was the common small species of eastern America, and which is known to

botanists as *Fragaria Virginiana.* The first distinct record of it in Europe is in 1624, when it was mentioned by Jean and Vespasien Robin, gardeners to Louis XIII. For more than a century it appears not to have taken on any new or striking forms. It bore a small bright scarlet berry, with a distinct constriction or neck near the stem and slightly acid flesh. It was in no way very different, probably, from the common wild strawberry which we now pick in the fields. It was never greatly esteemed on the continent, but in England it found greater favor. Duchesne writes of it, in 1766, that "they still cultivate it in England with favor" (avec honneur). The original form of the Scarlet or Virginian strawberry was still highly esteemed in England less than three-quarters of a century ago, at which time Barnet[2] wrote enthusiastically of it. "This," [the Old Scarlet Strawberry] he says, "which has been an inhabitant of our gardens nearly, if not fully, two hundred years, was doubtless an original introduction from North America. It is singular that a kind of so much excellence, as to be at present scarcely surpassed by any of its class, should have been the first known. It continued in cultivation considerably more than half of the period of its existence as a garden fruit, without any variety having been produced of it, either by seed or by importation from America." Yet Barnet knew twenty-six good varieties of the species and describes them at length; and four of them seem to have come directly from America, probably from wild plants. A considerable progress had been made in the amelioration of the strawberry in England at the opening of the century, therefore, from the Virginian stock or foundation; but the varieties were much alike and contain little promise of the wonderful development in the strawberry varieties which we now enjoy.

About 1712, a second species of strawberry reached Europe. This is the *Fragaria Chiloensis,* brought from Chili to Marseilles by Capt. Frezier. It reached England in 1727. It is a stout, thick-leaved shaggy plant which bore a large globular or somewhat pointed late dark colored fruit. In a few places, particularly about Brest, in France, it came to be cultivated

[2]Trans. London Hort. Soc., vi, 152 (1824).

for its fruit; but in general it met small favor, particularly as the flowers were often imperfect and it did not fertilize itself. It did not seem to vary much under cultivation; at least, when Barnet wrote, about a century later, he knew only three varieties in England which he could refer to it, one of which he considered to be identical with the original plant as introduced by Frezier. The Chilian strawberry grows along the Pacific coast in both North and South America, and it has been introduced into our eastern gardens several times from wild sources; but it always soon disappears. There is little in the record of this species, therefore, of promise to the American horticulturist.

In the middle of the last century, a third strawberry appeared in Europe. Some writers place the date of its introduction with considerable exactness; but the fact is that no one knew just when or how it came. Phillip Miller described and figured it in 1760 as the Pine strawberry, in allusion to the pine-apple fragrance of its fruit. There were three opinions as to its origin at that time, some saying it came from Louisiana, others that it came from Virginia, while there was a report, originating in Holland, that it came from Surinam, which is now the coast of Dutch Guiana. None of these reports have been either confirmed or disproved, although Gay, in making extensive studies of the growth of strawberries, may be said to have effectually overturned the Surinam hypothesis in his remark that to find a strawberry growing at sea-level within five degrees of the equator, is like finding a palm in Iceland or Hammerfest![3] Duchesne, in his Natural History of Strawberries,[4] 1766, described a Pine-apple strawberry as *Fragaria ananassa*, and while he did not know its origin he argued that it must be a hybrid between the Chilian and Virginian species. The pine-apple strawberries of England and France were found to be different from each other upon comparison, although the differences were such as might arise within the limits of any species or type, and by the end of the century most botanists began to regard the two as

[3]Ann. Sci. Nat. 4th Ser. viii, 203 (1857).

[4]Histoire Naturelle des Fraisiers. Par M. Duchesne fils. Paris, 1766.

variations of one stock. This general type of Pine strawberries, comprising the large-hulled type long represented by the Bath Scarlet and erected into a distinct species by Duchesne as *Fragaria calyculata*, has been collectively known for a century as *Fragaria grandiflora*, a name bestowed by Ehrhart in 1792, although this name, together with the English name Pine, is gradually passing from use. We may say that thus far there are three hypotheses as to the origin of the Pine strawberry—that it came from North America, from Guiana, and that it is a compound or hybrid of two other species; and we may add a fourth—that apparently accepted by Duhamel and DeCandolle and certainly by Gay—that it is a direct modification of the Chilian strawberry, and also a fifth, advanced by Decaisne[5] and accepted by others, that some, at least, of the varieties are products of the large, robust native form of our wild strawberry which is known as *Fragaria Virginiana* var. *Illinoensis*. I shall drop the Guianian origin as wholly untenable, and it will also be unprofitable to discuss directly the question of importation from North America, for we have nothing more than conjecture upon which to found any historical argument. I shall now endeavor to discover which of the remaining three hypotheses is best supported in the subsequent evolution of the plant itself: Is it a hybrid, a direct development of the Chilian species, or a form of the native variety *Illinoensis*?

It is first necessary, however, to determine from what ancestral type our cultivated strawberry flora has sprung. Barnet, writing in 1824, referred all cultivated strawberries to seven groups or classes, three of which comprise the small European varieties which are outside this discussion. The remaining four classes comprise all the large-fruited types, and they are as follows: 1. The Scarlet or Virginian strawberries, with twenty-six varieties; 2. The Black strawberries or *Fragaria tincta* of Duchesne, with five varieties; 3. The Pines, with fifteen; 4. The True Chili strawberries, with three varieties. The Blacks and Pines are so nearly alike that they can be classed as one. Although the Pine class is the most recent of the lot, it had already varied into twenty forms, and, moreover,

[5]Jardin Fruitier du Museum, ix, under "Frasier d'Asa Gray."

it contained the choice of the varieties. In this class is Keen's Seedling, which was then coming into prominence. This variety is the first conspicuous and signal contribution to commercial strawberry culture, and it marks an epoch amongst strawberries similar to that made by the Isabella amongst American grapes. It was grown from seeds of Keen's Imperial, which, in turn was raised from the White Carolina (known also as Large White Chili), which is regarded by Barnet as a Pine strawberry. Thomas Andrew Knight had made various interesting and successful crosses amongst the Scarlet or Virginian strawberries, but Keen's varieties so far excelled them, that Knight's productions were soon lost. From Keen's Seedling the present English strawberries have largely descended. The fruit of this remarkable strawberry was first shown in London in 1821. At this time there were apparently no important varieties in this country of American origin. Prince,[6] writing in 1828, enumerates thirty strawberries of American gardens, of which all, or all but one, are of foreign origin. The two important varieties, and the ones which supplied "the principal bulk of this fruit sold in the New York market" were Red Chili (referred by Barnet and by George Lindley[7] to the Pines) and Early Hudson, probably a variety of *Fragaria Virginiana.* Keen's berries are in the list, but these, according to Hovey and other later writers, did not thrive in America. As late as 1837, Hovey wrote[8] that "as yet the plants of nearly all the kinds in cultivation have been introduced from the English gardens, and are not suited to the severity of our climate." Mr. Hovey resolved to produce an American strawberry, and with a shrewdness which has rarely been equalled in the breeding of plants, he selected parents representing distinct ideals and the best adaptations to American conditions. Four varieties entered into a certain batch of crosses which he made. These were Keen's Seedling and Mulberry, both Pines, Melon, probably a Pine, and Methven Scarlet, a variety of the Virginian. From these crosses, two

[6]A Short Treatise on Horticulture, 72. New York.

[7]A Guide to the Orchard and Kitchen Garden, 487. London, 1831.

[8]Mag. Hort. iii, 246.

varieties were obtained,[9] one of which fruited in 1836. These were the Hovey and Boston Pine. Owing to the loss of labels, it is not certain which crosses gave these varieties, but Mr. Hovey was always confident that the Hovey sprung from Mulberry crossed by Keen's Seedling. The Hovey strawberry revolutionized strawberry growing in this country. It was to America what Keen's Seedling was to England; and it marks the second epoch in commercial strawberry culture. American varieties now appeared from year to year, and the greater part of them have come directly or indirectly from the Hovey and the Boston Pine. With the passing out of the Boston Pine and its immediate offspring, the term Pine has practically been lost to American strawberry literature, and the word is but a memory in the minds of the older men; but this is not because the class itself has disappeared, but, on the contrary, because it has become the dominant class and has driven out the Scarlet and all other competitors. The Hovey was a true Pine strawberry. Mr. Hovey grew it in his garden till the last, and it was my good fortune to secure a few plants of him shortly before his death. A plant is now before me as I write, and it has all the marks of the old Pine or Grandiflora type—the thick rounded dark leaves, stocky habit, stiff flower cluster, and large spreading calyx. All our commercial strawberries are Pines, and they compare well in botanical characters with the *Fragaria grandiflora* of the French gardens of a half century ago and with the famous Bath Scarlet and Pitmaston Black which were important Pines when Barnet wrote, specimens of all of which I have before me.

Our strawberries, then, are lineal descendents of the old Pine class, known to botanists as *Fragaria ananassa* and *F. grandiflora*. Now the question recurs, what is the Pine? where did it come from? how did it originate? Three hypotheses, as I have said, have been advanced which an evolutionary review of the subject is capable of considering. Is it (1) a hybrid? (2) a direct development of the Chilian strawberry? or (3) a modified form of our big wild strawberry, *Fragaria Virginiana* var. *Illinoensis?*

[9]Mag. Hort. vi, 284 (1840). Fruits of America, i, 25, 27.

1. Is the Pine a hybrid? The only reason ever advanced for considering the Pine strawberry to be a hybrid was the supposed impossibility of accounting for its attributes upon any other hypothesis. The ideas of hybridity were indefinite in those times, and intermediateness of characters was often supposed to be enough—as it is, unfortunately, too often at the present day—to establish a hybrid origin. In considering this matter, two questions at once arise: (a) Does the Pine bear evidence of being a hybrid? (b) Would hybrid characters perpetuate themselves? I am wholly unable to find, either in herbarium specimens of the plants themselves or in the pictures of the plants, any distinct evidences of hybridity. The Pine strawberries differ from the Chilian chiefly in their greater size, less hairiness and better fruit, and sometimes by somewhat thinner leaves, although this thinness of foliage is usually more apparent than real, being due to the larger size and consequently greater flexibility of the leaf without any real diminution in substance; and I have seen as thin leaves in wild *Fragaria Chiloensis* as in garden berries. But greater size could scarcely be obtained from the smaller or or least more slender Virginian strawberry, and better sweet fruit would not likely result from the amalgamation of the Chilian with the little acid fruit of the other. On the other hand, there is not a character of the Virginian, so far as I know—save possibly some thinness of leaf—which appears in the Pine. The slender erect habit, smooth stems, profusion of early runners, comparatively simple and very weak-rayed trusses, the small calyx, the early, light-colored pitted fruit—none of these marks of the Virginian strawberry appear in the Pine. Again (b), it is now known that one of the most characteristic marks of hybrids is their variability when propagated from seeds; and yet Phillip Miller declares that the old Pine strawberry came true to seed! A hybrid left to itself almost invariably departs from its mongrel type and reverts to one or the other parent; and yet here is a supposed hybrid which has held its attributes intact for one hundred and fifty years, and has presented a sufficiently unbroken front to overcome all competi-

tors.[10] There is not only no evidence in favor of a hybrid origin, but there is very much against it; and I have no hesitation in discarding the hypothesis in favor of a simpler and more philosophical one.

2. Is the Pine strawberry a direct development of the Chili strawberry? Every feature of the Pine strawberry suggests the Chilian species. It differs chiefly in its greater size and sometimes by a slight loss of hairiness, but the relative sizes of the parts remain much the same as in the wild type. It is now well known that variation induced by changed conditions of life and augmented by subsequent selection, is the common and potent means of the evolution and amelioration of plants. Hybridization rarely effects a permanent evolution of types. To suppose that the Chilian strawberry should have varied into the type of the common strawberry is in accord with all the methods of nature. But there are two considerations which convince me beyond all question that cultivated strawberries belong to *Fragaria Chiloensis:* (a) Their botanical characters, which I shall discuss more fully in the next paragraph, (3), and (b) direct experiment. The experiment which I now record I consider to be of great importance. In 1890, I sent to Oregon for wild plants of *Fragaria Chiloensis.* The strawberries which I secured were short, stocky, thick-leaved, hairy, evergreen plants, at once distinguishable from the garden sorts. They were planted in a spot convenient for observation. I pressed one of the original plants and have taken specimens from time to time since. A specimen taken in May, 1891, is scarcely distinguishable from the wild plants set the year before, but specimens secured in July of the same year, show the longer stalkes and larger leaves of garden strawberries; while an average specimen taken in June, 1892, is indistinguishable from common cultivated varieties in botanical features! Here, then, is a change in two years, and not by seeds, either, but in the same original plants or their offshoots. This change, while remarkable, is still not unintelligible, for I have seen many cases of as great modification in plants

[10]For a general discussion of the theory of hybridity, consult Bailey, Cross-Breeding and Hybridizing, 1892.

under cultivation; and the Chilian strawberry is widely variable in its wild state. Barnet has inadvertently recorded a distinct departure from the type of the Chilian plant, for he says that while this strawberry usually loses its leaves in winter, the varieties which have been bred from it keep their leaves. This change in my plants is due primarily, no doubt, to a greater amount of food, arising from the greater space which the plants are allowed to occupy; and it is possible that other environments may have assisted in the transformation. Having this experimental evidence, which so forcibly supplements direct botanical evidence and so well emphasizes the known laws of plant variation, I can no longer doubt that the garden strawberries are *Fragaria Chiloensis*, that the early botanists did not recognize the garden type as a departure from this species, and that this type has finally driven from cultivation the forms of *Fragaria Virginiana*. And I am glad to know that so great an authority as the elder DeCandolle accepted the opinion of Seringe (1825) that the Pine, Bath Scarlet and Black strawberries belong to the Chilian species, for the Prodromus makes Duchesne's *Fragaria ananassa*, *F. calyculata* and *F. tincta* all varieties of the Chilian plant. This was evidently the opinion of the Dutch plantsmen of the middle of the last century, also, for even before Duchesne described the Pine strawberry, these merchants sold it under the name of *Fragaria Chiloensis ananæformis*, indicating that it was regarded as a form of the Chilian species. And Duhamel, towards the close of the last century, said that the Pine could be raised from seeds of the Chilian. It is evident, however, that Seringe did not mean to say that all the large garden strawberries are offshoots of the Chilian species, for he has a variety *hybrida* of *Fragaria Virginiana*, which is a supposed compound of this species and the Pine. But if there was any hybridization in the early days, I am confident that it was only incidental and its effect was transitory. Our present strawberries are apparently direct and legitimate progeny of the Chilian species.

3. Is the Pine strawberry derived from *Fragaria Virginiana* var. *Illinoensis?* I confess that I have believed until recently that the garden strawberries are offspring of our native berry;

certainly I have always hoped that such would prove to be their origin. It is with much reluctance that I give up a pleasant and patriotic hypothesis; but everything is against it. I had long thought that the Pine strawberry of last century was only this robust form of our native species, a feeling to which the early conjectures of an American origin for the Pine lent color. But the Pine and the var. *Illinoensis* are so unlike in habit that they could not have been confounded. When the var. *Illinoensis* was really introduced into Europe in 1852 by Asa Gray, who secured it from the "wild and savage" country in western New York, it was thought to be so distinct from all other strawberries that it was made a new species, *Fragaria Grayana*, although it is scarcely different, except in greater size, from the common *Fragaria Virginiana*. If this plant possessed such eminent and variable qualities as to have made it the parent of our garden varieties, it would certainly have given indications of them somewhere in its wide and varied range. As it is, it has only now and then come into cultivation, when its behavior has been such that it has soon been discarded, as in the well known instance of the recent Crystal City. I have also tried to cultivate it, and its response, like the Crystal City, is mostly in leaves and runners, not in any permanent or striking modification. It is true that the botanical features of the garden strawberries and the var. *Illinoensis* are much alike, particularly in herbarium specimens, and for some time I was not able to separate them readily; but there are botanical characters, even aside from habit, which distinguish them. The garden strawberries are lower in habit, producing runners freely only after fruiting, with shorter petioles and more leaves springing from the crown of the plant, and the leaves are spreading—all of which are striking peculiarities of the Chilian plant,—while in the native plant the leaves stand up on long nearly perpendicular stalks and the runners are produced at flowering time; the leaflets are thick and firm in texture, broader than in *Illinoensis* and lacking the long narrow base of the native, with mostly rounder teeth, and they are particularly distinguished by the dark upper surface and the bluish-white under surface of the mature leaflets, the

color of the leaflets in the native plant being light lively green, with little difference between the two surfaces. In these points of difference, too, the garden berries are characteristically like the Chilian. The truss or inflorescence is different in the two. In the garden berries, the truss stands more or less oblique or is often prostrate, and it is broken up into two or three strong, often unequal spreading arms from which the short and stout fruit-stems spring, and this is the distinctive habit of the Chilian species; in the *Illinoensis*, the truss is erect and it breaks up more regularly at its top and the inflorescence is less strongly spreading in proportion to the number of fruits it contains, and the fruit-stems are weak and slender and more or less drooping. The calyx is very large in the garden berries, a fact which Duchesne recorded in the name *Fragaria calyculata* which he applied to the large-hulled forms like the old Bath Scarlet, of which many are in cultivation at the present time. The fruit in *Illinoensis* is small and soft and bright scarlet, usually with a distinct neck and deeply embedded seeds; that of the garden berries still maintains the features of the Chilian berry in its large size, mostly globular-pointed form, dark color and seeds borne more nearly upon the surface. The garden berries are in every way much farther removed from the native berry than they are from the Chilian. From the latter they differ most widely, as I have said, in the taller growth and less hairiness;[11] but even in these features they do not resemble very closely the *Illinoensis*. It may be urged that all these differences might have come about under the influence of cultivation if *Illinoensis* itself had been the parent of the garden forms, to which I reply that direct experiment does not sustain the assumption, and that the excellent engravings of the early forms of the Pine strawberry show the same differences. It was the study of these pictures which first led me seriously to doubt the East-American origin

[11] It is often said that the fruit of the Chilian strawberry is erect and that the garden berries differ in a nodding fruit, but this is an error. While the fruit stems of the true Chilian are stiff, I have never known them to be erect, and in wild plants which I have grown, the fruit has the same drooping habit as in the garden berries. The Chilian species probably varies naturally in its fruiting habit, but I have yet to find an instance in which it holds its fruit upright.

of our strawberries. No one can examine the excellent colored pictures of Keen's berries,[12] and other early varieties, without being struck by the thick blue-bottomed leaves and wide-spreading arm-like trusses—indisputable marks of *Fragaria Chiloensis.*

Yet, despite these important botanical differences, the garden berries and the native *Illinoensis* are much alike, as I have said; and this similarity is really one of the arguments in support of a different geographical origin of the two. Similar climates or environments produce similar results, and when old berry fields are allowed to run wild, the plants do not revert to the type of the Chilian species, but are modified rather more in the direction of the indigenous plant. In the fall, when the flower trusses are gone and growth has ceased, it is sometimes almost impossible to distinguish between the leaves of spontaneous garden berries and wild *Illinoensis;* but the flower clusters the following spring will be likely to distinguish the two. As a matter of fact, garden berries probably do not often persist long when run wild. They are unable to contend with the grass and weeds, although *Illinoensis* may find in similar circumstances an acceptable foothold. It is not strange, therefore, that those individuals from the old cultivated beds which longest persist should be those nearest like the native berries, for such would fit most perfectly into the feral conditions.

There is only one conclusion, therefore, which fully satsifies all the demands of history, philosophy, and botanical evidence, and this is that the garden strawberries are a direct modification of the Chili strawberry. The initial variation occurred when species were thought to be more or less immutable, and, lacking exact historical evidence of introduction from a foreign country, hybridization was the most natural explanation of the appearance of the strange type. This modified type has driven from cultivation the Virginian berries which were earlier introduced into gardens; and the original type of the Chilian strawberry is little known, as it tends to quickly dis-

[12]See, for instance, the plate of Keen's Seedling in Trans. London Hort. Soc., v 261.

appear through variation when impressed into cultivation. The strawberry is an instance of the evolution of a type of plant in less than fifty years, which is so distinct from all others that three species have been erected upon it, which was uniformly kept distinct from other species by the botanists who had occasion to know it best, and which appears to have been rarely specifically associated with the species from which it sprung.

THE PARASITIC PROTOZOA FOUND IN CANCEROUS DISEASES.

By Alice Bodington.

In the British Medical Journal for Feb. 26th, 1893, the "steady increase of cancer" is spoken of as a subject requiring serious attention, and as far back as 1887–8, the Council of the Association drew the attention of the Registrar-General to the "steady increase in the deaths from cancer," out of proportion to the deaths from all causes, and showed *that similar conditions exist in most civilized countries.* The "increasing mortality from this terrible disease, not merely kills nearly twenty thousand persons in England and Wales alone" [the southern part of one small island!] but kills the vast majority of them by slow and cruel torture continued during a long series of months, sometimes of years." Cancer, like insanity, seems specially to find in the highest conditions of civilization a hot bed in which it flourishes and spreads; and any clue which can guide civilized man to the secret of grappling successfully with this hitherto unconquerable foe, will be one of the greatest boons which science can confer upon mankind. To know where the enemy lurks, and in what form, is, in the case of parasitic diseases, not only half but sometimes all the battle; as the almost complete immunity from cholera of England has shown.

An army of keen observers has endeavoured for many years past to discover, if possible, the exciting cause of cancer, but till lately the prospect of discovering the foe appeared hopeless. The theory which seemed most firmly established, most consonant with scientific theory, was at the same time a singularly hopeless one. It was assumed that at the decline of life, or under conditions of lowered vitality in the whole or part of the body, certain embryonic structures—especially of the kind known as "survivals"—took on an abnormal growth, and rioted in the production of epithelial cells of a low type which

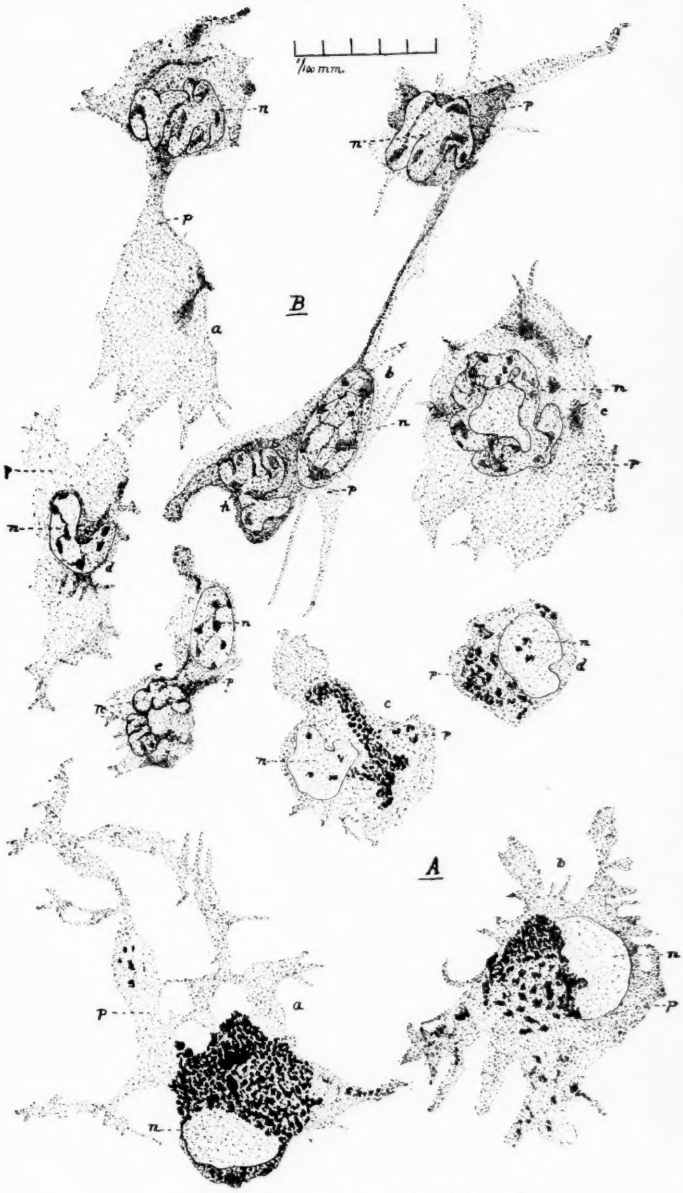
flourished at the expense of the healthy structures round them. Now any disease arising from degeneration or overgrowth of embryonic survivals, [such as the remains of the Wolffian duct in the female] sets at defiance all human precautions; the embryonic tissue is hidden, and no one can tell either when or why it begins to go wrong. If cancer owed its rise simply and solely to an overgrowth of embryonic tissue, there was no hope but in an early, a thorough, an unsparing use of the knife; no *stamping out* of the disease could be hoped for or thought of. All attempts to trace the disease to the action of bacteria failed. But during the last few months the patient, cautious, untiring labour of years of a number of distinguished pathologists has enabled them to detect the existence of organisms in cancer, which resemble, in all that is known as yet of their life history, the Sporozoa; and more especially the *Coccidium oviforme*. (Leuckart), of the rabbit.

Fig. 1.—*a*, Coccidium showing capsule full of granular protoplasm; *b* shows condensation of the protoplasm into one sphere, after two days' growth external to body; *c*, division of the single sphere into four daughter spherules, after four days' development; *d*, an empty ruptured cyst. (From photographs x about 500.)

The whole life cycle of *Coccidium oviforme* is now known; its discovery has been the work of more than thirty years, so that there is no reason for discouragement if some stages of the life history of the Coccidium found in cancer still elude research.

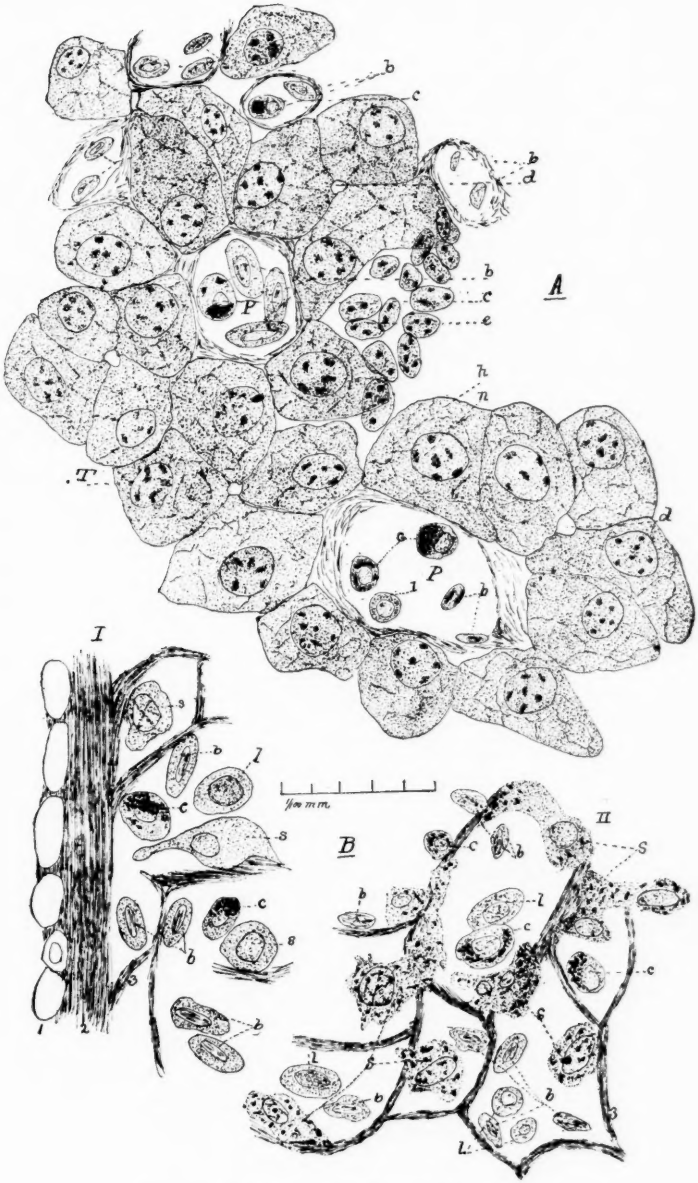
Dr. Galloway after describing the symptoms of coccidian infection in the rabbit, begins with the life of the protozöon after it leaves the body. "The organism" he says "as it escapes from the alimentary canal consists of a firm translu-

PLATE IV.



Leucocytes of Necturus and Cryptobranchus.

PLATE V.



Sections of Liver and Spleen of Cryptobranchus.

cent cyst oval in shape [see Fig. 1, *a*] enclosing a quantity of very granular protoplasm which fills the whole body. Very

Fig. 2.—Stages in Life History of *Coccidium oviforme*. *a, b*. Formation of crescentic spores within the daughter spherules external to the host (after Balbiani); *c, d*, sporulation within the host, division of the spores into numerous crescentic segments. (After photographs by Pfeiffer x 1,000.) From 'Morton Lectures,' by James Galloway, A. M.; M. D. Aberdeen. British Medical Journal. Feb. 4th, 1893.

soon after expulsion, and often while within the host, the protoplasmic contents contract [Fig. 1, *b*] and form a sphere lying free within the cell wall. Under suitable circumstances, this ball of protoplasm sends out projections and at length divides into four distinct smaller spherules [Fig. 1, *c*.]" These four spherules are "transformed[1] into four spores provided with a very resistant external covering. Each spore encloses two falciform and very delicate embryos, [Fig. 2.] which give birth to new parasites, and thus engender the terrible disease when swallowed in polluted food. The sporiferous coccidia penetrate into the digestive canal of rabbits, and the envelope of the spore protects the falciform embryos against the action of the gastric juice. So strong is the protecting capsule that the spores can live for at least six months outside the body [Galloway]. The epithelial cells of the small intestine and of the biliary ducts are the seat of the internal activity of the parasite, on reaching which a "new cycle of intense activity is observed. The falciform young take on a rounded shape, and probably acquire the power of locomotion. Most of the naked amœboid forms of the organism divide into small crescentic

[1] Carcinomata and Coccidia, Elias Metschnikoff, M. D. Chef de Service, Institut Pasteur. Revue Générale des Sciences Pures et Appliquées. Brit. Medical Journal. Dec. 10th, 1892.

sporules, which, in their turn, also become free, and myriads of young sporozoa are soon formed. These possess the "power of insinuating themselves into the protoplasm of epithelial cells, where they grow and become transformed into oval parasites resembling the adult form" [Metschnikoff]. In course of time, the epithelial cell wall is ruptured and the parasite escapes, without necessarily causing the destruction of the pest cell; it passes through the alimentary canal, gains access to the atmosphere, and thus attains the conditions necessary to recommencing its cycle of development. Having been shown the life history of the coccidian parasite of the rabbit,[2] we shall be better prepared to recognize the [apparently] kindred disease in man and some of the higher vertebrates. "Taking cancer of the breast as an example," says Dr. Galloway, "if careful microscopic examination is made, there will be found lying, most commonly within the cell body, rounded or oval structures varying in most cases from 2 μ to 10 μ in diameter, having, when large, a very distinct capsule, and containing a smaller body of variable shape. From the capsule there may be seen passing towards the centre numerous fine radial striations, ... and processes of a somewhat different character may also be seen passing from the nucleus towards the periphery; they are not so regular and appear to be prolongations of the nucleus.

"These bodies occur sometimes singly, sometimes in twos and threes, and occasionally to the number of nine or ten—and even twenty,[3] of small size—in a single cell. In a successful preparation each of the small ones will be seen to contain the usual nuclear substance (see Figs. 3 and 4). Similar structures of smaller size may be observed lying *inside the nucleus* of the epithelial cells. In this case the capsule, so very characteristic of the intracellular bodies, is very slight, and indeed, appears to be absent in most cases. "The intra-nuclear bodies also occur either singly or in small groups." Occasionally the

[2] See also Fig. XVII, Sporozoa; *Gregarinidæ* article Protozoa, Encyclopedia Britannica, pp. 852-3.

[3] "I have seen over 20 parasites in the same nucleus."—M. Armand Ruffer, M. D., *B. Medical Journal*, Nov. 5, 1892.

FIG. 3.

Cells from different cancers of the breast, showing various forms of parasites in the cell protoplasm × 1,200.

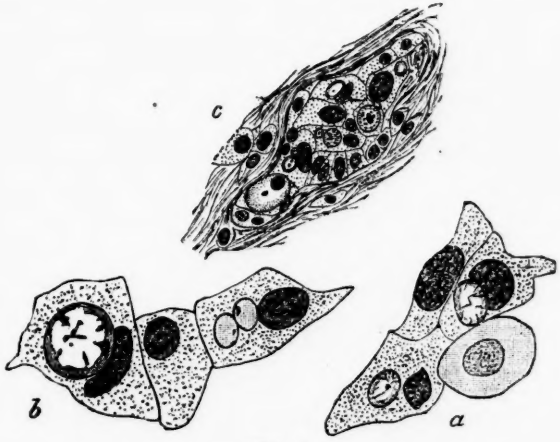


FIG. 4.

a and *b*, Groups of cells containing intracellular parasites × about 1,000; *c* cancer alveolus from edge of rapidly growing carcinoma of breast, showing numerous parasites × about 400.

bodies may be seen partly within and partly without the nucleus in the act of passing through the latter into the cell protoplasm. In certain cases the nucleus seems to become filled up with numerous small parasites which escape into the cell protoplasm after having burst through the nucleus.[4] The

[4] See "Preliminary Note on some Parasitic Protozoa found in Cancerous Diseases." By M. Armand Ruffer, M. D. and J. Herbert Walker, M. A. *B. Medical Journal*, July 16, 1892.

Also, "Recent Researches on Protozoa and Disease." By M. Armand Ruffer, M. D. *B. Medical Journal*, Oct. 14, 1893.

nucleus of the cancer cell when it bursts through over-distension with parasites, perishes, but when only one or two parasites escape, it usually heals up perfectly.

For the further life history of protozoa of cancer, we may follow Mr. Jackson Clarke.[5] In describing his examination of a myeloid sarcoma, he says: "In the most interesting portion of the neoplasm, its advancing border, the entire peripheral zone of the section could be examined from end to end without anything but amœboid psorosperms and remains of infiltrated connective tissues coming into view. In the centre of the field [Fig. 5] is a psorosperm in the plasmodium stage, in which spore-formation is commencing. Below is part of a giant cell containing one encapsuled and two amœboid psorosperms; numerous free amœboid parasites, and to the left is part of a large plasmodium, within which are nuclei and fibres undergoing digestion.

FIG. 5.

In this sarcoma, as in all the cancers, I have examined recently, there is, in the advancing zone, an army of amœboid psorosperms invading and digesting the tissues beyond, and *determining new growth in the special tissue with which the parasites have established a symbiosis.* For it appears that the curious inter-dependence of two organisms, known as symbiosis, has

[5] Sarcoma Caused by Psorosperms. By J. Jackson Clarke, M. B., F.R.C.S. *B. Medical Journal*, Dec. 24, 1892, and Jan. 21, 1893.

been established between the malignant parasite of cancer and certain epithelial and mesoblastic tissues. *These tissues are excited to enormous overgrowth by the presence of the parasites, whilst the tissues with which they have not established a symbiosis are invaded, devoured and destroyed.* Mr. Jackson Clarke thus describes the process: "The amœboid parasites make their way between the epithelial cells and pass in vast numbers into the connective tissue spaces beyond the epithelial part of the growth. In their passage they cause the rows of epithelial cells to separate, and thus bring about a multiplication of the points of epithelial ingrowth and detachments of small groups of epithelial cells. A considerable amount of inflammation is caused by the invasion of the vascular tissues by the amœbæ, with the same result as that seen in inflammatory papillomata; an extension of epithelial growth, and a formation of new blood-vessels. Most of the amœbæ disappear, but a small proportion enter epithelial cells, where, even in the non-nucleated stage, they could be detected," and the evil cycle is carried on.

Messrs Ruffer and Walker, the first pathologists who demonstrated the existence of the cancer parasite in England, state that they found a mixture of Foll's solution, with 1 per cent. of osmic acid, gave the most satisfactory results as a hardening reagent,[6] especially in demonstrating the intranuclear parasites. Biondi's mixture as a coloring agent brings out the organisms with all the clearness that can be desired. The "coccidia, stained a light blue, enclose a dark brown nucleus, the cancerous cell is stained a dirty yellow white, while its nucleus takes a green tint" [Metschnikoff].

Metschnikoff is of opinion than the coccidiosis of the rabbit is a miasmatic disease of the most typical kind, and that carcinomata also approximate to the category of miasmatic affections. "Although less pronounced than malaria or goitre," he observes, "the endemic character of cancer is a fact that has often struck observers. The frequency of these malignant tumors is far from being the same in all countries. By the side

[6] Second Note on Parasitic Protozoa in Cancerous Tumors. *B. Medical Journal*, Nov. 5, 1892.

of regions of the globe which are exempt, or very nearly so, from this disease [Faroë Islands] there are others where carcinomata are very common." According to Cohnheim's theory of a simple overgrowth of embryonic survival tissues, the average of victims to cancer should be the same in every part of the world, and liability to its ravages should be common to all the Metazoa. Metschnikoff points out another feature which cancers have in common with coccidian diseases—the exaggerated proliferation of the epithelial cells in the affected organs. How close the resemblance is, the following figures show.

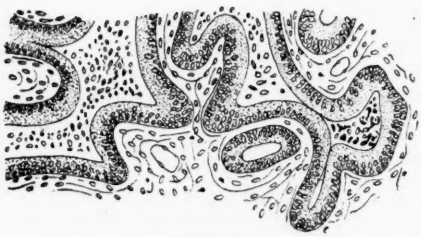


FIG. 6.

Adeno-Carcinoma of the Rectum in Man.

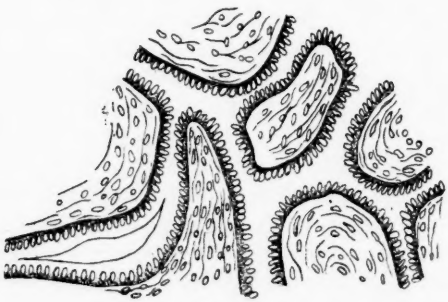


FIG. 7.

Hyperplasia of the biliary ducts of the rabbit under the influence of coccidia.

As yet, the study of parasitism in cancerous diseases is only beginning. The coccidia of the rabbit have been known for

half a century, but it is only quite recently that an important stage in their life-history has been made out. There are differences of opinion between observers; Mr. Jackson Clarke's amœba-like organisms do not exactly correspond with the various forms of parasites described by some other pathologists. It is thought possible that the whole life-cycle of the protozoön may be passed within its human host; in any case, its exogenous history is not known, and this stage is the one which it would be the most useful to discover, since we are, at present, in utter darkness as to the mode in which the contagion is conveyed to the host. Cancer is pronounced to be a disease in which heredity plays an important part. Does it do so in the same way that hereditary predisposition acts in tuberculous diseases; not by a direct transmission of the tubercle bacillus, but by some mysterious lowering of the vital powers of resistance? It is hardly possible to imagine that microsporidia, hereafter to develop into the protozon of cancer, can remain dormant for 50, 60, 70, 80 years.

The disease [so far as can be ascertained from experiments upon animals, themselves liable to cancer] is not directly transferable from one host to another. There remains, therefore, as a highly probable hypothesis that the exogenous form of the protozoön of cancer, like the flagellate monad of malaria and the coccidia of the rabbit, must be sought in contaminated soil or water. It is because this most important stage of the life history of the protozoön of cancer is unknown, that I have ventured to present a summary of some of the papers which have been appearing for some months in the *British Medical Jonrnal* to the readers of the AMERICAN NATURALIST; hoping that workers skilled in researches among the Protozoa may take up the subject, and may come to the aid of the brilliant band of pathologists who have thrown so much light on a most difficult problem.

THE ACTION OF LEUCOCYTES TOWARD FOREIGN SUBSTANCES.[1]

EDITH J. CLAYPOLE, M. S.

Among the many problems that yet await solution at the hands of the physiologist and histologist, those relating to the disappearance of so many leucocytes or white blood corpuscles from the animal body have long afforded a fruitful field for work. Under what conditions and by what means they are destroyed is as yet but partly known, and different theories are advanced as to the most probable method of this destruction. The constant relation, normally, that exists between the numbers of the white and red cells of the blood, in spite of the steady supply of white cells that is poured into the blood from the lymphatics, establishes the fact that somewhere there is as steady a drain on the numbers.

The nature of leucocytes as entities in the economy of the animal body is of especial importance in consideration of the second point and a careful study of these cells in a living condition helps one to realize their activities and powers. The ability of these cells to take up foreign substances by virtue of their amoeboid movement is very significant to the physiologist especially from a pathological standpoint. The great Russian morphologist, Metschnikoff, has based his phagocyte doctrine on the peculiarity given to these cells by the exercise of this power, giving to them in consequence an additional and important duty. They form, as it were, a guardian army in the animal body, ever alert and watchful for the invading enemy. A constant warfare is being waged between these leucocytes and all foreign material, organic or inorganic, that enters the system. By the process of ingestion the immediate influence

[1] This paper contains part of the results of an investigation carried on in the Histological Laboratory of Cornell University during last year. I wish to express my appreciation of the abundant material and facilities which were so generously put at my disposal. The whole paper afterwards received the first prize offered by the American Microscopical Society for original work in animal Histology.

of the substances is removed from the tissues. The balance of power continually wavers between these two hosts, on the one hand the leucocytes and on the other the different kinds of organisms and matter, injurious or non-injurious, to which the animal body is hourly exposed. If the invaders are too strong the results become evident in the sickness or perhaps death of the animal. But if the leucocytes are victorious, and are able to clear the system of the foreign substances, normal conditions are again established and with them the health of the individual. By no means is it necessary, however, that the conflict become apparent externally. This at least is the story picturesquely put as the founder of the "Phagocyte Theory" reads it. It may be rather extreme; certainly there are those who consider the protective part played by the leucocytes to be quite small, relatively speaking or merely incidental. That they can and do ingest foreign particles and are subsequently to be found in the various tissues bearing their loads, is however, proved. It is only the interpretations laid on the facts that differ.

Many experiments have been made from a pathological standpoint to prove, if possible, the true part played by the various tissues and cells in diseases, which owe their existence to the presence of foreign matter or foreign organisms in the body. Naturally from the medical standpoint these experiments have been made on mammals of various kinds, the only other animal used being the ever useful frog. In contrast to this basis of work is the normal physiological condition existing under ordinary circumstances in animal life. All the experiments, of which the results are here given, were made under as purely normal conditions as possible, in every way anything that might produce abnormal results, being avoided. The animals used for these experiments were the two salamanders, *Necturus maculatus* or the Mud-puppy and *Cryptobranchus alleghaniensis*, the Hell-bender.

For several reasons these animals afford peculiar advantages for an investigation of this kind. Of great importance among these is the large size of the leucocytes and of the various tissue cells, and also the comparatively simple structure of

the different organs. Another great advantage in the study of the living leucocytes lies in their activity in the ordinary temperature of a room, a fact, which affords an opportunity for the close observation of the process of ingestion. By mixing on a slide a small drop of fresh blood or lymph with a small quantity of lamp-black suspended in normal salt solution, the taking up or ingestion of the carbon by the leucocytes can be seen to take place while they pass through their amoeboid phases. In a few hours the cells become filled with carbon particles (Pl. IV), which are, however, contained exclusively in the cell body although appearances suggest their presence in the nuclei. These latter parts also exhibit amoeboid forms (Pl. IV). By watching the cells carefully the granules are seen to move across the nuclei and gradually leave it clear, proving beyond doubt that they are in the cell body.

In introducing the carbon into the living animals the following method was used. Into the abdominal cavity of the animals from ¼–1 c. c. of a mixture of lamp black, gum arabic and normal salt solution was injected. Here it should be said that in these animals this cavity forms practically a great lymph space, in which the carbon is ingested by the leucocytes, the latter then pass into the blood circulation and from that to the various organs and tissues. After periods varying from 4–10 days different animals were killed and the blood and tissues examined. In the case of Necturus, owing to the presence of external gills, the time of the appearance of the carbon-laden cells in the blood could be easily determined. By etherizing the animals and microscopically examining the circulation of the blood in the gill filaments once or twice a day the time of the appearance and also of the disappearance of ingested cells can be noted. The earliest appearance was on the 6th and the latest on the 9th days after injection. After 16 days a few scattered cells still remained. The results now given were chiefly obtained from a specimen of Cryptobranchus killed 10 days after injection.

In the microscopical examination of the tissues the first difficulty encountered lay in the presence of a large amount of natural pigment in the tissues. This is confusing both from

the similarity in colour and from the necessary obscuring of structural parts. Caustic potash destroys melanin, but boiling is required and that of necessity injures the tissues. Ether, alcohol, acids and strong alkalies will also remove the colour, but the last two destroy the tissues and the first two decolorize so slowly as to be practically useless. By means of hydrogen dioxide the most successful results were obtained. The sections when cut and fastened to the slide were put in a vial of a 2% solution of the liquid. In from 6–48 hours, depending on the amount of pigment present, the color is reduced from black to a pale yellow without any attendant injury to the tissues. The process of decolourization is materially hastened by placing the vial containing the liquid and tissue in the strong sunlight and if desired all traces of the pigment can be removed. Practically it was found to be a great advantage to leave sufficient colour to mark the position of the pigment-bearing cells. By this method the black ingested leucocytes were easily distinguished wherever they occurred, and no chance for confusion remained.

Serial sections were made of the following parts: the spleen, kidney, ureters, liver, lung, stomach, muscle and skin. In all these parts ingested cells were present, but the positions and relations differed somewhat with the different organs. In the kidney (Pl. VI) carbon-laden leucocytes were in the blood capillaries, in the glomeruli, in the lymph spaces surrounding the capsules of the glomeruli, in the urinary tubules and in the nephrostomes. These latter parts are peculiar structures present in the amphibian kidney and are marks of a much more primitive form of that organ than exists in mammals. They consist of small ciliated funnels opening on the ventral surface of the kidney directly into the abdominal cavity. A small tube then unites these funnels with the urinary tubule arising from the glomeruli. The ingested leucocytes were in these funnels and by a series of sections they could be found to pass down the tube and into the urinary tubule. No doubt the number of leucocytes that pass from the blood circulation into the tubules is largely increased by additions from this source. No signs of ingested leucocytes in other than these

places were found, or any trace of free carbon. Serial sections made of the ureters (Pl. VI) close to their openings into the cloaca showed masses of ingested cells. This indicated that a considerable number of such cells found their way out of the body in this way. Uningested cells were also found among those containing carbon. In the liver (Pl. V) ingested cells were found in the blood vessels alone. No extra-vascular carbon-laden leucocytes were present. In the stomach (Pl. VII) the carbon-laden cells were in the blood-vessels, in the epithelial tissue of the stomach and free on the inner surface, showing a gradual passage from the vessels to the epithelial surfaces. In the lungs (Pl. VI) practically the same time condition existed and also in the skin (Pl. VII). In the latter leucocytes could be traced from the blood-capillaries through the various layers and finally free on the outer surface of the skin. That these outside had not come from accidental external contact was proved by the fact that no red corpuscles were among these leucocytes and with the very rapid coagulation that takes place in amphibian blood it would be impossible for the white cells to be completely isolated from the red. In various parts of the muscular tissue, either in the lymphatics or simply between the muscular fibres, ingested cells occurred rarely.

In all these parts there was absolutely no evidence for the presence of free carbon or carbon in any other cells than leucocytes. When, however, the spleen (Pl. V) was examined some peculiar and very interesting differences were found. The carbon was contained in leucocytes of a similar nature to those in previous cases, but in addition round the malpighian corpuscles there was what seemed at first sight to be a free deposit of carbon. But when carefully observed the carbon proved to be contained in cells that from their position were judged to be spleen-pulp cells. The distribution of the carbon in these cells differed exceedingly from that present in the leucocytes. Instead of being massed irregularly the carbon was evenly scattered through the cells, and, owing to the extended condition of the latter, covered a large area. When the fact of the presenee of carbon in these cells was established the question of the means of the transfer of the carbon from

the leucocytes to the spleen cells at once arose. It was already proved that no free carbon entered the blood circulation. Consequently the spleen cells must have obtained their foreign material either directly or indirectly from the already ingested leucocytes in the blood. Two ways are open for this to take place. The leucocytes may in some manner discharge their load, which is afterwards taken up by the spleen cells, or the spleen cells may ingest the leucocytes and consequently the carbon. The latter seems to be the most plausible explanation. Moreover from the amount of carbon contained in the spleen cells the number of leucocytes destroyed in this manner must be considerable.

A brief summary of the results of the experiments is contained in the following statements:

1. No free carbon was present in any part examined.
2. All carbon was contained in leucocytes except in the spleen, where true splenic cells also contained it.
3. Ingested cells were both extra- and intravascular, except in the liver.
4. Ingested cells were free on mucous and epidermic surfaces; in the stomach, lungs and skin.
5. Ingested cells were in excretory organs with waste products, kidneys.

From the above results it is seen that the number of leucocytes in the body suffers a constant loss in three ways, by the wandering out of the cells on mucous and epidermic surfaces, by passing away with waste products and through ingestion by the splenic cells. The large numbers found in all three conditions show that the destruction of leucocytes through these ways is by no means insignificant. Moreover as no pathological conditions, so far as could be determined, were induced in the animals by the treatment, there is no reason to believe this loss to be other than a normal occurrence.

This method of removing the artificially introduced material by the leucocytes suggests at least the manner of the removal of any foreign matter that may enter the circulation during life. The leucocytes thus perform the duties of scavengers of the body in addition to their other important duties, even if by

the very assumption of this office, they ultimately become waste material and as such pass away from the system.

One of the most interesting of the many problems that, even in these few experiments, have presented themselves, remains as yet unsolved. Owing to want of time the ultimate fate of the carbon contained in the spleen-pulp cells remains unascertained, nor can any suggestions be offered. Only after more prolonged experiments could it be determined whether the carbon disappeared from the cells or remained permanently in them. After the determination of this point if the first condition was found to obtain, the question as to the method of this removal would remain to be settled. In all the problems connected with the blood and circulation this perplexing organ seems to play an important part and when, setting aside function, differences of opinion exist as to structure, it can easily be seen that discussion on this part of the experiments involves doubtful and difficult problems. As is usual in any investigation many doubtful points have been raised that yet await settlement, leaving an interesting and fruitful field for further work.

NOTE.—The author wishes to express her indebtedness to the American Microscopical Society for the use of plates illustrating this article.

PLATE IV.

Leucocytes.

A. Group of carbon-laden leucocytes showing amoeboid phases.
   a. b. Leucocytes of Necturus.
      n. Nucleus.
      p. Cell-body.
   c. d. Leucocytes of Cryptobranchus.
      n. Nucleus.
      p. Cell-body.

   Drawn from dried preparations.

B. Group of Leucocytes, showing amoeboid cell-bodies and amoeboid nuclei.
   a. b. c. Leucocytes of Necturus.
      n. Nucleus.
      p. Cell-body.

b. Shows three nuclei, two in amoeboid movement and one resting.
d. e. Leucocytes of Cryptobranchus.
n. Nucleus.
p. Cell-body.
e. Has three nuclei, two amoeboid and one resting.
Drawn from stained preparations.

PLATE V.

A. Surface section of liver of Cryptobranchus.
p. Capillaries of blood-vessels.
t. Liver-cells.
b. Red corpuscles in the capillaries.
d. Small intercellular capillaries of bileduct.
e. Epithelium of the larger bile vessels.
h. Hepatic cell-body.
n. Nucleus of hepatic cells with nucleoli.
Note the absence of extravascular ingested leucocytes.

B. Vertical section of the spleen of Cryptobranchus.
I. Part of the section near the surface.
1. Peritoneum.
2. Layer of fibrous tissue forming the capsule.
3. Trabeculæ passing from capsule among splenic cells.
c. Carbon-laden leucocytes.
b. Red corpuscles.
l. Leucocytes, non-ingested.
s. Splenic pulp-cells.
II. Ental part of the section.
Lettering as above.
Note the ingested spleen pulp cells and the different distribution of the carbon particles in them from that found in the leucocytes; also the absence of ingested splenic cells in the superficial part of the spleen.

PLATE VI.

A. Vertical section of lung of Cryptobranchus.
E. Ectal surface.
R. Ental or respiratory surface.

P. Blood capillary.
c. Carbon-laden leucocytes.

Note the presence of ingested leucocytes in extravascular tissue as well as on the ental surface of the lung.

B. Section of kidney of Cryptobranchus.
I. Transection of the ureters and cloaca, showing masses of ingested cells.
a. Ureters.
c. Carbon-laden leucocytes.
l. Non-ingested leucocytes.
II. Transection of urinary tubules.
c. Carbon-laden leucocytes.
III. Nephrostomic funnel, showing ciliated mouth.
c. Ingested leucocytes.
l. Non-ingested leucocytes.
IV. Vertical section of the kidney near the ventral surface.
G. Glomerulus.
P. Capillaries of blood-vessels.
T. Urinary tubules.
s. Lymph space around the glomerulus.
o. Origin of a urinary tubules, with small ciliated epithelium.
b. Red corpuscles.
c. Carbon-laden leucocytes.

Note the presence of extravascular ingested cells.

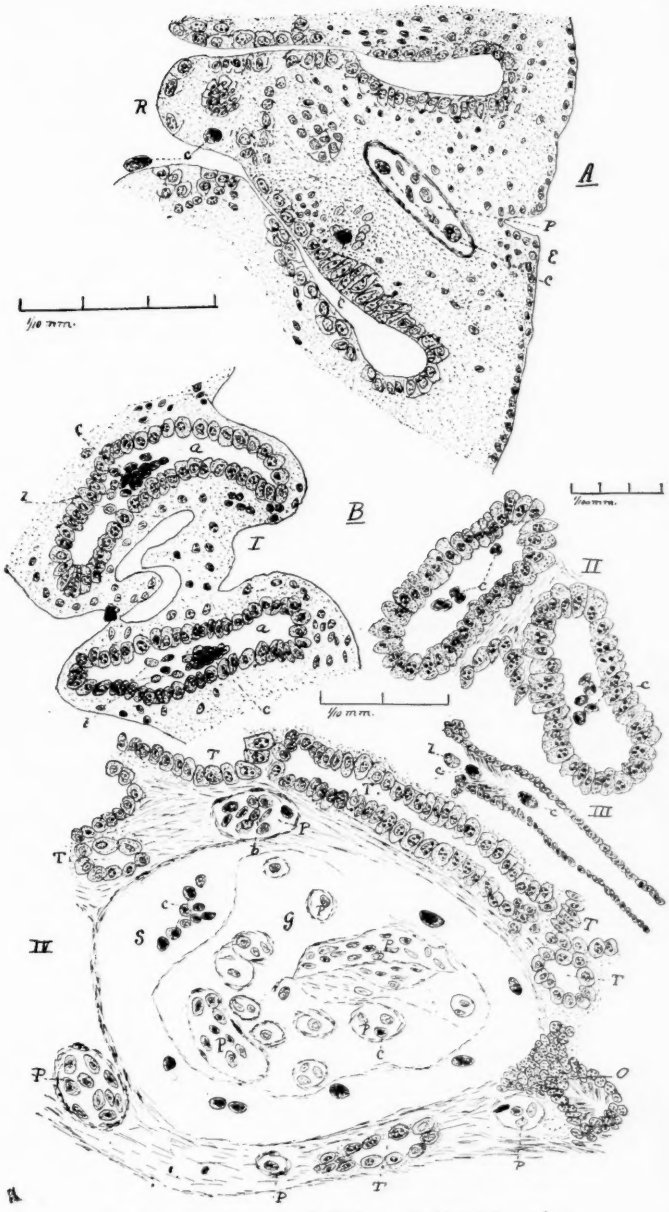
Plate VII.

A. Vertical section of stomach of Cryptobranchus, near the pyloric part.
I. Submucosa.
II. Muscularis mucosæ.
III. Mucosa.
c. Carbon-laden leucocytes.

Note the presence of the extravascular ingested cells.

The figure is diagrammatic in so far that the locations of the ingested cells are taken from different sections and put into one figure.

PLATE VI.



Sections of Lung and Kidney of Cryptobranchus.

B. Vertical section of the skin of Cryptobranchus.

G. Large mucous glands.

c. Carbon-laden leucocytes.

The ingested cells are wandering to the external surface from the blood-vessels.

THE WHITE-MARKED TUSSOCK-MOTH (ORGYIA LEUCOSTIGMA SMITH AND ABBOTT) IN CHICAGO.

Dr. Joseph L. Hancock.

Throughout the months of June and July 1893, there were myriads of caterpillars of the White-Marked Tussock-Moth (*Orgyia leucostigma*) crawling on the sidewalks, in the grass and in the streets in the section south of the river in Chicago. These caterpillars could be seen constantly changing their positions, drifting from place to place. One need not have searched far to determine the cause of these shifting movements—for the White Elm trees (*Ulmus americanus*) which are set out in some of the resident portions, on the sides of the streets, at that time were almost completely defoliated; showing that they were infested by this insect. As soon as one tree became despoiled of its leaves the caterpillars centered their attacks upon other trees adjacent to them. The beautiful hairy larva of Orgyia marked with yellow, black, and two little bright vermillion red spots on the ninth and tenth joints is a conspicuous object. It seems to have few natural enemies and parasites that are menacing its welfare here.

Notwithstanding the possible existence of a few deadly foes, it enjoys immunity from these to a larger extent than many other insects, as shown from the fact of the growing preponderance of individuals in the last three years. The Wheel-bug sometimes attack the caterpillars, but the former does not occur in the city, whereas bats, cuckoos and robins are in insufficient numbers to make any appreciable impression on them. In the middle or latter part of August, the male moths are most abundant, flying about at night. Attracted by artificial lights, they frequently are seen on the glass of the shop windows along the streets. One appeared on the inside wall of a house (August 28, 1893) and was caught by the writer. The position of the hairy forelegs placed in front of the body,

with other characteristics which it possesses, are attractive to the entomologist. Natural selection has favored the structure of the legs, the feathery antennæ, the subdued ashy-gray color, all to one purpose; to lend in blending its form with the natural environment on the bark of trees. In fact we find

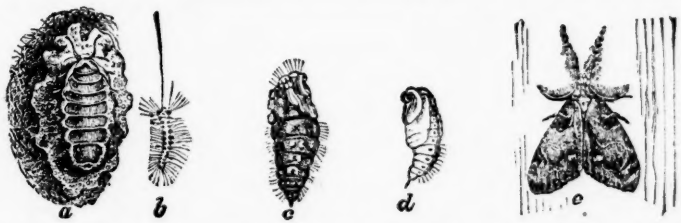


Fig. 1. White-marked Tussock-moth: *a*, female moth on cocoon; *b*, young larva hanging by thread; *c*, female pupa; *d*, male pupa; *e*, male moth. [After Riley].

the caterpillar favored by its very conspicuousness, while nature is effecting good to the same species on a diametrically different line by so modifying the form of the male moth as to deceive its enemies from seeing it. Parasitism may be looked upon as a recent enemy—for nature is strangely unable to cope against their invasion. The female pupa within a frail cocoon may be pierced with ease by the ovipositor of a Hymenopterous parasite and is obliged to give up her life's juices in hopeless submissson to the offspring of the parasite hatching within her body. Along these lines we are to look forward for a means of extermination. On September 30, 1893, the tree trunks along the streets in the locality above named, were examined with a view of learning some further facts about Orgyia. A number of cocoons were found as the result of the search, all being near the ground. These were taken home to my study, where on opening them, they proved to be quite old, of a dirty color, and many were deserted. On two of the cocoons there were plastered masses of small white eggs made adherent by some glistening tenacious frothy substance which had become hardened on drying. Inside of others were empty pupas and cast off skins. Some Hymenopterous parasites had hatched and lived in the old pupa husks, which later had made their exit through an irregular hole cut

out at the forward end. In another cocoon there still lay in store another suprise, for on tearing apart the hairy fibers, out rolled a small undetermined gray spider which was snugly secreted and warmly covered for the winter. The spider was tumbled into a bottle of preserving fluid and now bears testimony to the unprofitable experience of tenanting a ramshackle old dwelling of Orgyia.

RECENT BOOKS AND PAMPHLETS.

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RECENT LITERATURE.

Chapman on the Birds of the Island of Trinidad.[1]—During the early part of 1893, Mr. Chapman collected birds and made notes in the Island of Trinidad, and the paper we are here to notice is the printed account of his observations in that interesting quarter of the world. Its author leads off with a brief description of the Island and the various places upon it visited by him during his short stay there. Then follows several pages devoted to "The Faunal Position of Trinidad," in which he very conclusively proves that that island "faunally, that is naturally, has no connection whatever with the West Indies, but is entirely South American in its affinities." Further we are informed that an "analysis of the distribution of the 199 resident land-birds common to Trinidad and the continent shows that it belongs in the Colombian, rather than in the Amazonian subregion. Thus 153 of these birds are found in both Guiana and Venezuela, while twenty-five are found in Venezuela but not in Guiana, and only eleven are found in Guiana but not in Venezuela." An interesting table is also given showing the South American element in the avifauna of Trinidad, as compared with the off lying islands of Tobago and Grenada.

Mr. Chapman also deals in this paper with the Bibliography of the Trinidad Avifauna, and an entire and very important section of the work is devoted to "General Remarks on Trinidad Bird Life." Here the questions of "Number of Species;" "Migration;" "Call-Notes and Songs;" "Nesting" and "The Colors of Tropical Birds" are dealt with in a manner well calculated to excite the interest, and compel the attention of the philosophic student of bird-life in any part of the world where these observations may be read.

This memoir is concluded by "A List of the Birds of the Island of Trinidad," which is prefaced by the following remark by its author: "While I believe that the most natural order in which to arrange lists of species of any class of animals is to begin with the lowest forms and end with the highest, most writers on South American birds have followed exactly the opposite plan, and any attempt to change would now result in so much confusion that I have decided to follow the system of

[1] CHAPMAN, FRANK M., *On the Birds of the Island of Trinidad.* Author's Ed. ext. Bull. American Museum of Natural History, Vol. VI, Art. 1, pp. 1–86. New York, Feb. 16, 1894.

previous writers, even though I disapprove of it." (p. 21). We cannot agree with Mr. Chapman in this theory, and see no real valid reason why we should perpetuate the errors of our predecessors in the science of ornithology.

The classification of the birds of Trinidad adopted by Mr. Chapman is the only faulty feature of this otherwise careful work by a Naturalist who has thus far in his career earned a reputation for great painstaking.

He divides the Trinidad avifauna simply into two primary ORDERS —the PASSERES and the MACROCHIRES.

In the first named the following families are represented, viz: the *Turdidæ;* the *Troglodytidæ* [Sic.]; the *Mniotiltidæ;* the *Cœrebidæ;* the *Vireonidæ;* the *Hirundinidæ;* the *Tanagridæ;* the *Fringillidæ;* the *Icteridæ;* the *Tyrannidæ;* the *Pipridæ*; the *Cotingidæ*; the *Dendrocolaptidæ;* and the *Formicariidæ.*

This may answer for the Passeres, but his order Macrochires is very carelessly arranged. In it he retains the "Humming-birds, Swifts, Goat-suckers, etc.," and leads off with the family *Trochilidæ*, between which and the Swifts there appears no family dividing line; nor is there between the Swifts and the Goat-suckers. The "etc." given above seems to include also without dividing family lines, Wood-peckers, Kingfishers, Trogons, Jacamars, Cuckoos, Toucans, Parrots, Owls, Vultures, Hawks and Pigeons, Jacamas, and indeed all the rest of the avifauna of the Island, including all the water-birds. At the close of the "list" some of the birds are enumerated entirely in their wrong places in the system. I refer to the point where *Crypturus pileatus* follows *Colymbus dominicus.*

The writer of this review has long since failed to recognize the naturalness of the so-called order "Macrochires," but here certainly is an application of it that is, at the best, quite unique in ornithological literature.—R. W. SHUFELDT.

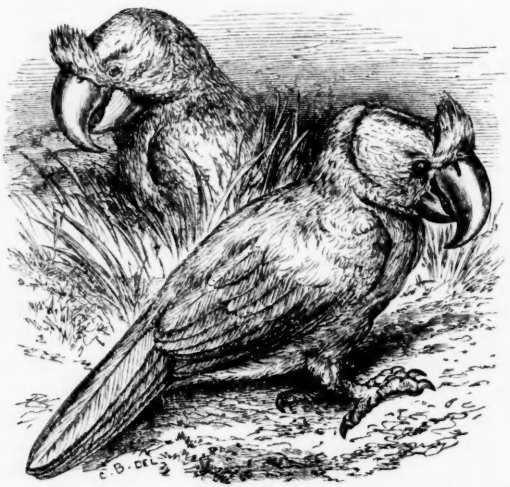
Memoirs of the National Academy of Sciences, Vol. VI,[2] embraces 331 pages, of which the following is the list of contents;—On the Capture of Comets by Planets, especially their Capture by Jupiter, by H. A. Newton.—Atmospheric Electricity, by Robert Catlin, U. S. A.—On Certain New Methods and Results in Optics, by C. S. Hastings.—The Proteids or Abuminoids of the Oat Kernel, by T. B. Osborne.—A Comparison of Antipodal Faunas, by Theodore Gill.—Families and Sub-Families of Fishes, by Theodore Gill.—Human

[2]Memoirs of the National Academy of Sciences, Vol. VI. Washington, 1893.

Bones of the Hemenway Collection in the U. S. Army and Medical Museum, by W. Matthews, Surgeon, U. S. A., Dr. J. L. Wortman and Dr. J. S. Billings.—Further Studies on the Brain of *Limulus polyphemus*, with notes on its Embryology, by A. S. Packard.

Four of the eight memoirs are profusely illustrated.

A Dictionary of Birds.[3]—Under this title, Professor Newton publishes a series of articles contributed to the ninth edition of the Encyclopedia Britannica, modified and supplemented by recent acquisitions to the knowledge of the Avian history. The contributions of Dr. Gadow bring the anatomical portion up to date, and those of Dr. Lydekker furnish the paleontology. The material is arranged in alphabetical order and includes the names of birds in common use, excluding local names except such as have found their way into some sort of literature; technical terms; and all of the important branches of Ornithology; as flight, migration, extermination, embryology, eggs, color, geographical distribution, etc.



Lophopsittacus mauritianus M-Edw.; the extinct parrot of Mauritius.

The numerous illustrations add to the attractiveness of the work. Many of those representing the bill, wings and feet, are those pub-

[3]A Dictionary of Birds, by Alfred Newton; assisted by Hans Gadow; with contributions from R. Lydekker, C. S. Roy and R. W. Shufeldt. Pt. I and II. London, 1893, Adam and Charles Black, Publishers.

lished many years ago by Swainson, which have never been excelled for expressiveness.

The Dictionary is one which every Naturalist should have at hand, as furnishing in convenient form full information in every department of the subject. The work is critical, and the conclusions of its authors carry with them the weight of their well known mastery of the subject. The treatment of questions of nomenclature is especially to be commended. As they insist on correct orthography, and discard names published without descriptions, or which are flagrantly incorrect in meaning, they furnish a much needed corrective to tendencies to pursue an opposite course, which are just now too prevalent in this country. We give some examples of the cuts which illustrate the two volumes already issued.

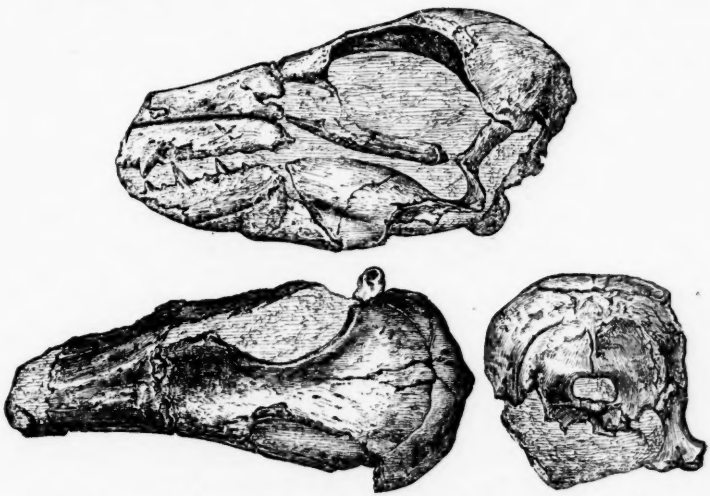


FIG. 1. *Odontopteryx toliapicus* Owen. English Eocene.

Eleventh Report of the State Mineralogist of California.[4] —This report, as originally submitted to the Board of Examiners, consisted of over 2,000 pages of manuscript, much of which, while valuable in itself, would be of no practical use to the miners in whose interest the volume was prepared. It was accordingly put in the hands of Mr. Charles G. Yale for revision. By judicious omission and conden-

[4] Eleventh Report of the State Mineralogist, Wm. Ireland, Jr. (First Biennial) Two years ending September 15, 1892. Sacramento, 1893.

sation he reduced the copy to 844 pages of manuscript which, together with the illustrations, makes an octavo of 612 pages. The report is confined almost exclusively to mining in the counties of California, the exceptions being a paper on Hydraulic Ejectors, by Mr. E. A. Wiltsee, and a dissertation upon American mining law, by A. H. Ricketts.

The prefatory report of Mr. Ireland includes an interesting synopsis of the results of the geological investigations of the different field assistants.

The engravings for this report add materially to its value.

Annual Report of the Canadian Geological Survey, 1890–91.[5]—This volume, of 1,556 pages, consists of 13 separate reports, bound in two parts, with maps and illustrations descriptive of the geology, mineralogy and natural history of the various sections of the Dominion to which the several reports relate. These have been published separately at intervals during the past two years, and abstracts of many of them have been given in previous numbers of this journal

Eleventh Annual Report of the Director of the U. S. Geol. Surv.[6]—This volume contains a report of the work of the divisions of Hydrography and Engineering during 1889–90, the statement of the Director to the House Committee on Irrigation, the report of Mr. A. H. Thompson, geographer, and an account of the disbursements of money. The statement of the Director comprises a general discussion of the problems of irrigation in the arid lands of the United States, and a résumé of the larger aspects of the problem, as well as other facts of general interest.

The text is illustrated by several maps and cuts of measuring instruments in use by the Survey.

Annual Report of the New Jersey Geological Survey for 1892.[7]—The investigations carried on in the several departments of the Survey are embodied in the report of the State Geologist under the following heads: Surface Geology, R. D. Salisbury; Cretaceous and and Tertiary Formations, W. B. Clark; Water-Supply and Water-

[5] Annual Report Geological Survey of Canada, 1890–91, Vol. V. Parts 1 and II. Ottawa, 1893.

[6] Eleventh Annual Report of the U. S. Geol. Surv. to the Secretary of the Interior, 1889–90. By J. W. Powell, Director. Part II, Irrigation. Washington, 1891.

[7] Annual Report of the State Geologist of New Jersey for 1892. Trenton, N. J., 1893.

Power; C. C. Vermeule; Artesian Wells, L. Woolman; The Sea-Dikes of the Netherlands and the Reclamation of Lowlands and Tide-Marsh-Lands, J. C. Smock.

In the administrative report, Mr. Smock calls attention to the desirability of securing the Highlands for a forest reservation, and a permanent gathering territory for a water-supply, and refers somewhat at length to the subjects reported upon by the heads of the several divisions.

The illustrations consist of maps, diagrams and plates. Among the latter are three reproductions from the Challenger Expedition Report on Deep Sea Deposit.

Marbles and Limestones of Arkansas.[8]—This report, by T. C. Hopkins, represents Volume IV of the Annual Rept. of the Arkansas Geol. Surv. for 1893. Part I consists of an introductory chapter giving a general description of the marble area of the State, followed by a discussion of limestones in general, including their composition and origin, geological and geographical distribution, varieties and uses, and a detailed description of the different limestones of Arkansas. In part II the author states briefly the origin and uses of marble, gives a résumé of the marbles of United States and other countries, and describes in detail those of Arkansas, giving especial attention to their use for building purposes. In order to make the work of practical value in establishing a marble industry in the State, two chapters are devoted to quarrying and the preparation of the stone.

The text is illustrated by a number of good plates, and a set of six map sheets.

[8] Annual Report of the Geological Survey of Arkansas for 1890. Vol. IV, Marbles and other Limestones. By T. C. Hopkins, Little Rock, Ark., 1893.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Discovery of a New Fauna in the Cenozoic Beds near Zagreb, and its Relations with the Recent Fauna of the Caspian Sea.—For a number of years, Professor Brusina of the University of Zagreb has been studying the Molluscan fauna of that region. In a recent publication he reports finding a wonderfully rich fossil bed at Markusevic from which he obtained 101 species, over half of which are new. A generic comparison of the fauna of Markusevic with that of Okruljak shows that the Pelecypoda are the dominant type in the latter locality, while the gasteropods prevail in the former. A comparison of the fauna of these two localities in Croatia with the recent fauna is of extreme interest. To quote Professor Brusina, "They seem to have relations with the fauna of Lake Baikal; my new genus, Baglivia, is similar to the genus Liobaikalia Martens (Leucosia Dybowski). Also some of our Valvata recall some species of the same genus which live in Lake Baikal.

"I have mentioned the genus Caspia. Dr. W. Dybowski, to whom we are indebted for the most important papers on the Gasteropods of Lake Baikal and of the Caspian Sea, created this genus for a series of small species which live in the Caspian Sea. Now, I have discovered near Zagreb several fossil species of the same genus. In a paper published in 1884, I established the genera Zagrabica and Micromelania for some fossils found near Zagreb; in 1891, in the work referred to on the recent Molluscs in the Caspian Sea, Dybowski describes several species of Micromelania and one species of Zagrabica now living in that sea. Thus, the genera Zagrabica, Micromelania, Caspia and Limnocardium (Adacna), fossil in Croatina, are to-day living in the Caspian Sea. It is, then, evident that the present fauna of this sea is the remnant of the rich fauna of the Congeria beds of Austria, Hungary, Banat, Croatia, Slavonia, Servia, etc., although, quite recently this fact has been doubted.

"A comparison between the fossil fauna of the neighborhood of Zagreb with the recent fauna of the Caspian Sea destroys the hypotheses of Humboldt, Peschel, Middendorf and others, concerning the origin and relationship of the Caspian Sea and of its present fauna. While these authors claim the origin of the fauna of the Caspian Sea, in the Black and circumpolar seas, my studies and my researches lead me to look for its origin in the pre-pleistocene Cenozoic beds of Croatia

and in those of the other countries above cited." (Proceeds. Congrés. Internatl. de Zool. Deuxiéme Sess. a Moscou, 1892. Deuxième Partie Moscou, 1893.)

Coasts of Bering Sea and Vicinity.—Mr. G. M. Dawson's notes on some of the coasts and islands of Bering Sea confirm the theory of a former land connection of Asia and North America in that region. Soundings in Bering Sea show that the continental plateau of North America extends westward in Bering Sea, meeting with that of Asia in the vicinity of Cape Navarin, north latitude about 60°. The available evidence shows that this submarine plateau, together with much of the flat land of western Alaska, was covered by a shallow sea during the later part of the Miocene period. The formation of the Aleutian Islands began in the late Eocene or early Miocene, continued with vigor during Miocene, and later in an intermittent way up to the present time. No traces of glaciation by land ice were found in the Bering Sea region, and the absence of erratics above the sea-line shows that it was never submerged for any length of time below ice-encumbered waters. (Bull. Geol. Soc. Am. Vol. 5, 1894).

The Age of the Pliocene Mammalian Fauna of the Central Plateau of France.—M. Deperet recognizes two distinct and successive mammalian faunas in the different Pliocene horizons of Italy, France and England. First, an older one, belonging to the lower and middle Pliocene. It is characterized by a great number of old extinct forms, as Hippotherium, Hyaenarctos, Paleoryx, Dolichopithecus, many of the Glires, large Monkeys with Asiatic affinities, Antilopes related to the African species, and by the rarity of the relative simplicity of the horns of the Cervidæ. The absence of Equus, Bos and Elephas constitutes a negative character throughout all Europe. Second, a more recent fauna, found only in the upper Pliocene. The old genera, except the Mastodon, have disappeared; the horse supplants Hipparion; Bovidæ appear for the first time in Europe; Monkeys persist in Italy; *Elephas meridionalis* is found nearly everywhere with *Mastodon arvernensis* and *M. borsoni*.

In Italy the old fauna is badly represented by sporadic débris, but the recent types are found abundantly in the brackish and fluviatile deposits which overlie the marine Pliocene of Astesan, and in the fluviatile gravels in the valley of the Arno.

In the south of France the older fauna occurs and affords the best means of determining the exact stratigraphic position of the beds in which the fossils are found.

In la Bresse the older fauna is found in the lacustrine deposits of the lower Pliocene and in the fluviatile beds of the middle Pliocene; the recent fauna is finely developed in the sands of Chagny.

In England the Hipparion fauna is found in the nodule-beds at the base of the red Crag and in the red Crag itself, while the Equus fauna is contained in the fluvio-marine Crag.

A comparison of stratigraphic details shows that the older Pliocene fauna is lacking in the Central Plateau region of France, and the horizon of Perrier with the Mastodon bearing sands of Puy, of Coupet and of Vialette must be placed in the upper Pliocene not withstanding the total absence of *Elephas meridionalis.*

The fauna of Sainzelles presents the same characters as that of Perrier and can be considered only as a simple local sub-division of the same bed.

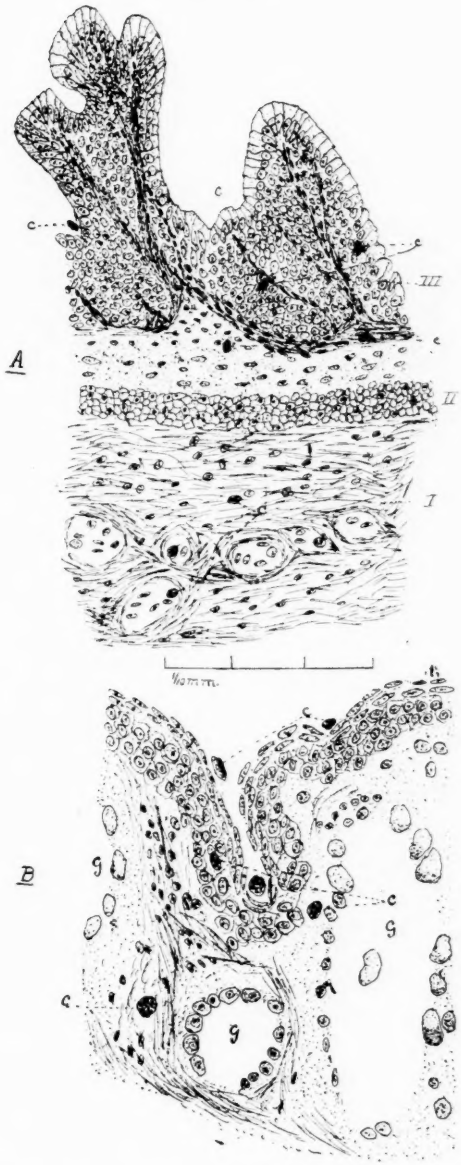
From these facts M. Deperet also concludes that the basalts intercalated in the gravels of Perrier and the Mastodon-bearing sands of Puy, and the breccias which accompany them, belong to the upper Pliocene, and, chronologically, are very near to the basalts of the Plateau. (Compte-rendu des Séances de la Soc. Geol. de France, 1893.)

Plistocene Diastrophism in the California Coast.—Mr. A. C. Lawson has obtained data which establishes (1) The uplift from the sea of the entire coast of California from San Francisco to San Diego, in Plistocene time, from 800 to 1500 feet. (2) A differential movement of the crust, to a remarkable degree, in the vicinity of Catalina Island, and near the city of San Francisco, also of Plistocene age.

The uplift changed the contour of the coast, which at the close of the Plistocene had had the aspect of an archipelago and was well supplied with harbors. The Channel Islands are remnant of the Pliocene condition, but the harbors have disappeared with one exception.

The orogenic movement resulted in the lifting of the Merced series, into its present condition and the upthrust of the Montara Mountain, which is described as having a central granite mass from which the strata of all ages dip quaquaversally. The mass antedates the oldest sedimentary strata on its flanks. In his conclusions the author states that the subdivisions Eocene and Neocene are not suited to the west coast of California. The reversal of the epeirogenic movement from a process of depression to that of uplift is believed to correspond

PLATE VII.



Sections of Stomach and Skin of Cryptobranchus.

with the beginning of the Plistocene, so there was no break in the marine conditions throughout the epochs, the Pliocene merging into the Plistocene. Between the Pliocene and Miocene, however, there was an important interval of erosion. (Bull. Dept. Geol. University of California, Vol. 1, 1893.)

Geological News.—PALEOZOIC.—Mr. M. R. Campbell's stratigraphical studies in Montgomery and Pulaski Counties in western Virginia, result in the establishment of two periods of disturbance in the Appalachian system. One folded the limestones and produced basins at the beginning of the Devonian period, the other elevated these basins and brought the period of sedimentation in them to a close near the middle of the lower Carboniferous period. These two periods of disturbance, in connection with other well established periods of overlaps show that deformation in the Appalachian system has been practically continuous since early Paleozoic time. (Bull. Geol. Soc. Am. Vol. 5, 1894.)

MESOZOIC.—Dr. J. W. Gregory describes two new species of Chilostomata (*Membranipora jurassica* and *Onychocella bathonica*) from the Jurassic beds of Normandy, France. This is the first description of Polyzoa of this order in the Jurassic. (Geol. Mag., Feb., 1894.)

From the evidence of fossil flora and certain stratigraphical facts, Mr. Benjamin Smith Lyman is inclined to put the Newark Brownstone at an earlier age than Mesozoic. Since the recent researches of Canadian geologists have proved that much of the so-called Trias of New Brunswick and Nova Scotia is really Permian and even Carboniferous, the author calls attention to the doubtful determination of the age of the beds in question, and suggests a thorough examination of the paleontological record in order to determine their position. (Proceeds. Amer. Philos. Soc. Vol. xxxiii, 1894.)

CENOZOIC.—The age of the yellow clay in the eruptive formations of Gravenoire, in which a human skeleton was found in 1891, has been fixed by MM. Girod and Gautier. A study of the stratigraphy and fauna of that region leads to the conclusion that the bed in question is a post-glacial deposit of the Reindeer age. (Rev. Scientifique, Feb., 1894.)

The collection of Bird bones from the Miocene of Grive-St. Alban, France, sent by Dr. Forsyth Major to Mr. Lydekker for identification, comprises six determinable species, of which four are new: *Strix sanctialbani, Palæortyx maxima, P. grivensis, Totanus major.* The

specimens of *Strix sanctialbani* confirm Mr. Lydekker in the view that the Strigidæ must be subdivided into the families Strigidæ and Bubonidæ. (Proceeds. Zool. Soc. London, 1893.)

According to Mr. F. L. Ransome, the eruptive rocks of Point Bonita, California, are differentiated into two formations which, from chemical analysis, seem to have been derived from the same basic magma. One is compact, amygdaloidal, does not show crystals to the unaided eye and is markedly spheroidal in structure; the other is distinctly crystalline, traversed by irregular joint planes, and is not spheroidal. The latter is intrusive into the sandstones and is, therefore, of later age. The spheroidal basalt was probably poured out anterior to the deposition of the sandstone and afterwards elevated to its present position. The author believes the spheroidal structure to be a flow phenomena. The lava issued in a viscous condition, one sluggish outwelling of lava being piled upon another to form the whole mass of the flow. The former center of volcanic activity, as indicated by the character and position of these formations, probably lay to the seaward at some little distance off the present coast. (Bull. Dept. Geol. Univ. of California, Vol. 1, 1893.)

BOTANY.[1]

Holophytes and Hysterophytes.—For some time I have been using in my lectures, and occasionally in some botanical writings which have not yet appeared in print, the two words here given.

Every botanist has felt the need of a word which should express what we mean when we say "a green plant," or a "chlorophyll-bearing plant," and he has felt even more the need of a single term to express what he means when he says a "parasite or saprophyte," a "parasitic or saprophytic plant," or a "chlorophyll-less plant." The terms I have used are not strictly new. We already have "holophytic" with precisely the meaning I would give this form of the word. Hysterophyte has often been used with nearly the meaning I would restrict it to, and its older use has practically become obsolete. The words may well be restricted then as follows: "holophyte," a chlorophyll-bearing plant, which is neither parasitic nor saprophytic, i. e., an independent plant so far as its nutritive functions are concerned; "hysterophyte" a chlorophyll-less plant, either a parasite or a saprophyte, i. e., a dependent plant so far as its nutritive functions are concerned. The etymologies are so evident that I need not give them here.

CHARLES E. BESSEY.

The Microörganisms of Fermentation.[2]—The name of Professor Emil Chr. Hansen is connected with a reform in the industry based upon fermentations. The reform is spreading all over the civilized countries, and it is gradually entering into the wine-industry, and, recently, into the manufacturing of vinegar. Hansen's principle is to work in the brewery with *pure yeast*, and this principle will doubtless be extended to other manufacturing trades the underlying causes of which are life-activities of microörganisms.

The famous Carlsberg Laboratory, where Hansen works, and from where the Kjeldahl nitrogen method sprung, could, a few years ago, not accomodate all of the students that came from all parts of the world. Consequently Hansen's collaborator, Alfred Joergensen,

[1]Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska,

[2]Joergensen, Alfred; Microörganisms and Fermentation. New edition, translated from the re-written and much enlarged third edition in German by Alex. K. Miller, Ph. D., F. I. C., and E. A. Lennholm, and revised by the author. With 56 illustrations. London, F. W. Lyon, Eastcheap Buildings, E. C., 1893. (pp. VIII + 257, 9x6).

established a laboratory for the purpose of giving specialists an opportunity of becoming acquainted with the new system, and, at the same time, supplying cultures to breweries. While Hansen worked mainly in the line of bottom fermentation, Joergensen worked with top fermentations.

All we who have had an opportunity of working with Joergensen, are well acquainted with his text-book; it is as thorough as its author and as familiar to us as our catechism.

Chapter I treats of microscopical and physiological examinations in the line of lower cryptogams; Ch. II of examinations of air and water, including Hansen's zymotechnical analysis of air and water; in Ch. III bacteria form the subject; Ch. IV contains the moulds, Ch. V (pp. 111–203) contains a full account of the alcoholic ferments, methods of analysis in this special line, and descriptions of the different species of Saccharomyces and their nearest relatives. In Ch. VI the application of the results of scientific research in practice (pp. 204–227) is set forth, and a bibliography and an index have finally been added.

Botanists are, as a general rule, too much absorbed by the questions of nomenclature, etc., to look into practical questions; therefore, we often see, in text-books, very singular remarks on the subject of fermentations. A book like Joergensen's text-book should not be absent from any laboratory, chemical or botanical, because fermentations are subjects of study in both places, and because the work in these lines is very instructive, both to botanists and to chemists. To the special attention of all of these, the book of Joergensen is most cheerfully recommended.

J. Christian Bay.

ZOOLOGY.

The Cestodes of Herbivorous Animals.[1]—Dr. C. W. Stiles and Albert Hassall have issued a well illustrated list of the adult tape worms of cattle, sheep and allied animals. In this work the authors have had the great assistance to be derived from studying many of the original types. From this paper we learn that the domestic cattle are infested by 8 adult cestodes, the goat by 2, the sheep by 11, etc. The new species described are *Monezia oblongiceps* from a South American Coassus, *M. trigonophora* from sheep, and *M. planissima* from sheep and cattle. In connection with each species is a good anatomical description.

Cladoceran Crustacea.[2]—Prof. E. A. Brige, in the third of his "Notes on Cladocera," enumerates 63 species of Cladocera as having been found in Wisconsin and Northern Michigan. A table is given showing the distribution of each species in the lakes explored, and four plates illustrate the new or little known forms enumerated. The new species are *Moina affinis, Ceriodophina lacustris, Daphinia breviceps, Bunops* (n. g. for *Macrothrix serricaudata* Daday and *B. scutifrons* nov.) *Chydorus faviformis, Anchistropis minor.* A most interesting comparison is made between the Cladoceran fauna of Wisconsin and various regions of Europe.

Eyes of the Harvestmen.—Dr. Frederick Purcell has just issued an account of the eyes of the Phalangids[3] which is rather difficult to understand, on account of the absence of all illustrations. The Phalangids have two eyes which Purcell homologizes, without a doubt, with the median eyes of the scorpions. Like them, they are developed from three layers, the middle forming the inverted retina. The retinulæ each consist of five cells arranged in a circle and each retinular cell gives rise to a rhabdomere so that the rhabdom is five-parted and the longitudinal grooves on the outer surface of each rhabdomere give it a star-like section. The retinal cells are pigmented distally, the nucleus and nerve termination are in the proximal portions. Besides these there are club-shaped pigment cells in the dis-

[1]U. S. Dept. Agric., Bureau of Annual Industry, Bulletin, 4, 1893.
[2]Trans. Wisc. Acad. Sci. Arts, IX, 1893.
[3]Ueber den Bau der Phalangiden Augen; Dissertation. Berlin, 1894.

tal retinular region. The principal differences between these eyes and the middle eyes of the scorpion lie in the absence of a central cell, in the anatomy of the retinulæ and in the absence of inter-retinular pigment cells from the Phalangids. As a summary Purcell says: "The anterior middle eyes of the spiders, the eyes of Phalangids and the middle eyes of the scorpions, as well as the middle eyes of Limulus, represent a series of homologous structures, which are characterized by an inverted retina with retinulæ or at least rhabdomes."

Range of Placostylus.—A study of the geographical distribution of the land molluscan Placostylus, by Mr. C. Hedley, leads to some interesting conclusions. According to that author, Wallace's theory of a land connection between Australia and New Zealand is untenable. Mr. Hedley's theory is that the various islands where Placostylus is found, embracing the archipelagoes of Solomon, Fiji, New Hebrides, Loyalty, New Caledonia, Lord Howe and New Zealand, are the remnant of a continental area to which he gives the name, Melanesian plateau. This plateau was never connected with nor populated from Australia; its fauna was probably derived from Papua via New Britian. New Zealand and New Caledonia were early separated from the northern archipelagoes, while the Fijis remained to a later date in communication with the Solomons, but were severed from that group before the latter had acquired from Papua much of its present fauna.

The author calls attention to the fact that not the depth but the permanence of the ocean is the real limit to the distribution of the forms of life. (Proceeds. Linn. Soc. N. S. W., 1892).

The Scales of Lepidosteus.[4]—Mr. W. S. Nickerson finds that in *Lepidosteus* the dermal scleroblasts give rise to three different products: (1) calcareous scale material, (2) ganoine, and (3) a ganoine membrane. There is no differentiation of the cells, but rather a modification of the function of the same cells at different periods of their history. The ganoine has been called the enamel layer, but it is not enamel, as its development and chemical reactions show. It is secreted on the outer surface of the scale by cells of dermal origin, not by epidermal cells, as is the case with true enamel. The epidermal cells over it are unmodified and separated from the scale by a dermal layer of cells. Such a condition is found no where else among vertebrates.

During the development of the scale, spines tipped with an enamel layer are formed, but disappear before the maturity of the scale. Their number and irregularity of distribution over the scale opposes

[4]Bull. Mus. Comp. Zool., XXIV, No. 5 (1893).

the supposition that the ganoid scale is a number of placoid scales used together. There can be no homology between them except in their both being dermal structures. In the Selachians the basal plate originated in connection with the formation of spines, but in the Lepidosteus the spines have degenerated while the basal plate has developed independently at the same time sinking deeper in the dermis.

In the Telosts there is no ganoine, but a modification of the dermis takes place similar to that in *Lepidosteus*. The same sinking or a tendency to reduction of superficial parts and increase of the deeper parts, involving the reduction of spines. In the lower Teleosts the spines are connected with the scale by connection tissue only, thus showing a more degenerate condition than in Lepidosteus.

It appears, then, that the Lepidosteus and Teleost scales have been derived from the placoid scale along independent lines.—F. C. KENYAN.

Mammalia of Mt. Pocono.—Considering the fact that hitherto no systematic collecting of small mammals has been attempted in the Pennsylvania mountain districts the following notes may seem worthy of record. During the latter part of June and first week of July, 1893, in company with Mr. Witmer Stone, I spent about ten days collecting birds and mammals in the vicinity of Mt. Pocono, Monroe Co., Penna. The general situation and elevation of the locality warranted a much more northern fauna than that found in the southeastern part of the state, and it is hence not at all surprising that such boreal forms as *Zapus insignis*, *Evotomys gapperi* and *Tamias striatus lysteri* were obtained. None of these, so far as I am aware, have been previously recorded from Pennsylvania.

A list of the mammals collected is as follows:

Blarina brevicauda.—This shrew was the most abundant of any species noted; the specimens secured forming over 30 per cent of the whole number collected. I found them, as Dr. Merriam has said, moving about during the day, and on my afternoon visit to the traps rarely failed to secure one or more. Several were taken in the same runs with *E. gapperi*.

Sorex platyrhinus (Dobson).—Two specimens of a small shrew were secured which Mr. G. S. Miller, Jr. has kindly referred for me to this species, using the name as a provisional designation. A third specimen, badly decomposed, was found in the middle of a road through the woods. Of this the skull only was preserved.

Evotomys gapperi.—Five specimens of the red-backed mouse were

secured, of which four were taken in decayed stumps, and the fifth in a runway under a log.

Sitomys americanus.—A young male and female in plumbeous gray pelage, with a narrow streak of brown on the flanks were the only ones collected.

Arvicola pinetorum.—Two specimens were secured under a log.

Zapus insignis.—An adult male of this handsome mouse was secured July 4th, on the bank of a stream in a ravine covered with a growth of hemlocks and laurels.

Tamias striatus lysteri.—We found this chipmunk quite common among the rocks and young growths where the timber had been recently destroyed by fire. The specimens collected, on comparing them with skins from Maine, were found to be typical *lysteri.*

Sciurus hudsonius.—A tolerably common species. A suckling female, shot on June 29th, is an interesting specimen as showing a peculiar phase of the molt. The long winter coat is considerably bleached on the upper parts and sides; and from the nose to a line drawn across the head just back of the ears, upon the anterior margin and extreme tip of the ears, and for a space upon each shoulder it is entirely replaced by the new growth of shorter yellowish rusty hairs annulated with black. The bright chestnut of the dorsal region, besides being very much worn, is interrupted just behind the shoulders, by an irregular patch of the new hair, in which the black predominates. The sides of the head and neck as far forward as the roots of the whiskers, the greater surface of the ears, a space on the back of the head, and the entire posterior portion of the body still retain the old pelage.—Wm. A. Shryock.

The Mammals of Thibet.—Several French travellers have explored China, Mongolia, Thibet and Indo-China, and their reports are full of interest. Every naturalist knows of the brilliant discoveries made 25 years ago by M. l'abbé Armand David; they were revalations of the richness of the Thibetan fauna. Since that time M. le Dr. Harmand, M. Pavie, M. Joseph Martin, le prince Henri d'Orleans and M. G. Bouvalot, M. Dutreuil de Rhins and the French missionaries of Tatsi-en-lou, directed by M-go Biet, have contributed much to our knowledge of the natural products of central and eastern Asia.

The collections made by le prince Henri d'Orleans have been referred to the Museum d'histoire naturelle. They comprise a large number of mammals and birds, the former of which forms the basis of a paper by M. Milne-Edwards. The birds have been studied by M. le Dr Oustalet.

The fauna of Turkestan is very distinct from that of the Thibet region. The Tian-Chan mountains of Chinese Turkestan are inhabited by large quadrupeds very different from those of Europe; they are wolves bears, deer (*Cervus xanthopygus* A. M.-Ed.), roebucks (*Cervus pygargus*). Tigers and panthers from the south of Asia are seen there frequently. In the sterile and sandy desert which extends from Korla to Lob-Nor the fauna offers different characteristics; gazelles are abundant there (*Gazella subgutturosa*). They are seen in small troupes in the middle of those plains covered with a scanty herbage, and Tamarisks, where the only trees are stunted and twisted poplars, and where the river Tarim is lost in a great swamp. The color of the skin of these quadrupeds harmonizes admirably with that of the sand. The foxes are light yellow (*Vulpes flavescens* Blan.); *Gerbillus psammophilus* is common and resembles that of the Sahara; a cat (*Felis shaviana*) resembles in color and markings *Felis margaritæ* of the deserts of the northern part of Africa. Wild camels are found in small herds.

On climbing the slopes of the Al-tyn-Tagh, other animals are found; *Ovis poli*, *Pseudovis burrhel*, *Pantholops hodgsonii*, *Gazella picticauda*, wild Yaks with large diverging horns, covered with dark brown hair, *Equus kiang*, and numerous rodents.

From the Tengri-Nor to Batang the fauna is stilll more varied. The mountains, covered with conifer forests and thickets of rhododendron, afford shelter to many mammals. Travellers report seeing a black monkey with a long tail, which, however, they could not get near; but they captured several rhesus Macaques, remarkable for their large size, their long thick fur, and short tails. These animals, when adult, are comparable in size to the large Cynocephali of Africa; they live in large troops, are seen even in the midst of snow, and hide themselves among the rocks. The natives treat them respectfully and often feed them. A young female, bought in May, 1890, at Kiam Tatie, was sent to Paris, and is now in the menagerie of the museum. Although kept in a warm room, it has not the thick long fur to which it owes its specific name of *Macacus vestitus*. Neither *M. thibetanus* nor the snub-nosed monkey, *Rhinopithecus roxellanæ*, have been seen from Batang to Tsienlou.

Panthers and Ounces are abundant, also *Lynx rufus*; *Felis scripta* is also found here, and another species with a large body, belonging to the same group as *F. chaus*, but differing from it, which I have named *F. bieti*; *F. tristis*, which attains considerably larger dimensions than it is generally accredited with; *F. manul*, remarkable for the black

tint on its chest, and belonging to a variety named by Hodgson, *F. nigripectus*. Wolves are common, and Cuons with long reddish brown hair, probably *C. duchunensis;* Foxes, Skunks and Martens (*Putorius davidianus* and *Martes flavigula*); large bears, one black with a yellow pectoral spot, the other, brown, shading to bright yellow, identical with the one described by Fr. Cuvier under the name, *Ursus collaris*. *Arctonyx obscurus* A. M.-Edw. and *Ailurus fulgens*. *Ailuropus melanoleucus* is unknown in this region.

The Glires are represented by *Pteromys alborufus*, numerous squirrels (*Sciurus erythrogaster* and *Sc. fernyi*), *Tamias maclellandi*, *Arctomys robustus*, different species of Mus, a Siphneus distinct from those already known (*S. tibetanus*), *Lepus hypsibius*, the feet of which are colored red by contact with the ferrugineous soil, two species of Lagomys (*L. koslowi* and *L. melanostomus* Büchner).

The ruminant species are numerous. Wild Yaks, *Ovis nahoura*, and a species with compressed horns, believed to be new; *Pantholops hodgsonii*, a large Nemorhedus with a body like *N. bubalinus* of India, but having a long mane of white hair, and related to the species *Nemorrhedus argyrobhœtus*, described by Père Hendes; two varieties of musk, Moschus, one gray-black in color, the other lighter, inclining toward yellow; *Elaphodus cephalophus*, the same species as that found in the valley of Moupin, but not quite so red; a roebuck similar to the one in the mountains Thian-Chan, but not so robust (*Capreolus pygargus*); a deer belonging to the group Rusa, but differing from the Sambur of India and Cochin China by its bushy tail which is longer and blacker, by larger ears, its muzzle bordered with black and its feet which are yellowish-white at their extremities.

It is astonishing that in such a short time the explorers could have collected such a large number of species. It is evident that fresh research in the same field will bring to light other mammals. Mgr. Biet, Bishop of Diana, and apostolic missionary of Thibet, has kindly given orders to have hunters sent in search of the animals along the upper Yang-tse-Kiang; but with these at hand, we see the resemblance between the animals of this part of Thibet and those of Indo-China, and we also note, at the same time, certain peculiar characters which are not found elsewhere. (Prof. A. Milne-Edwards in Proceeds. Cong. Internatl. de Zool, Deuxième Session à Moscow, 1892. Moscow, 1893.)

Zoological News.—ARACHNIDA.—In two papers,[5] Mr. George H. Carpenter enumerates five species of Pycnogonids brought back by

[5]Sci. Proceed. Roy. Dublin Socy., VII, 1892: VIII, 1893.

Prof. A. C. Haddon from Torres Straits. Of these, three (*Parapellene haddonii, Ascorhynchus tenuirostris* and *Rhopalorhynchus clavipes*) are new.

HEXAPODA.—The last number of the Kansas University Quarterly (Vol. II, No. 3, 1894) contains "New genera and species of Dolichopodidæ," by J. M. Aldrich, and "Descriptions of North American Trypetidæ," by W. A. Snow.

MOLLUSCA.—The molluscs collected during the United States Expedition to West Africa, in 1889–90, have been made the subject of a report by Mr. R. E. C. Stearns. In all there are 122 species, birds-it uted as follows: Pelecypods, 35; Marine Gasteropods, 69; Land Gasteropods, 82; Cephalopods, 5. (Proceeds. U. S. Natl. Mus. Vol. V, 1893.)

CHORDATA.—Balanoglossus has recently been found at Broken Bay and at Jervis Bay, New South Wales. The genus was previously unknown from Australia.

Prof. W. E. Ritter describes[6] a new Tornaria from California, the first indication of the existence of Balanoglossus on the Pacific coast of the United States. This Tornaria, like the Bahaman form, possesses tentacles on the longitudinai ciliated bands, and like the form described by Metschnikoff has a second circular band of cilia. In the oldest Balanoglossus obtained by the transformation of the Tornariæ, but two pairs of gill slits had appeared, and there is farther a thickened œsophageal band of epithelium which Professor Ritter would compare, in function at least, with the endostyle of Tunicates and Leptocardii. Lastly, the nerve cord does not arise by delamination but by a sinking down of the whole ectodermal nerve layer in a manner somewhat like that in Amphioxus. In the stages studied there was no trace of neuropore or neural canal.

An important collection of fresh water fishes from Borneo, examined by M. Leon Vaillant, extends the number of species now known from that Island to 322. M. Vaillant points out the strong resemblance of the fish fauna of Borneo to that of Indo-Malaysia. (Revue Sci., Feb., 1894.)

According to Mr. F. C. Test, the "Gopher Frog," *Rana aesopus* Cope, is subterranean in its habits, living in the burrows of the Gopher Turtle. It probably feeds on the insects living in the burrows, for these holes possess a flourishing insect fauna, to a great extent peculiar to them. (Science, 1893.)

[6]Zool. Anzeiger XVIII, 24, 4894.

EMBRYOLOGY.[1]

Experimental Embryology.—Two interesting pieces of work employing experimental methods have been recently published by Dr. T. H. Morgan. The first[2] appears to be but a preliminary account to be followed by more detailed illustration. The second[3] is complete and illustrated by figures drawn by the associated author Umé-Tsuda.

The former deals with the echinoderm—the latter with the frog-egg.

In the sea-urchin *Arbacia punctulata* minute fragments of the eggs may be fertilized and undergo cleavage, but there is no evidence that fragments develop unless they have part of the female pronucleus. Hence Boveri's experiments[4] upon the cleavage of e-nucleated fragments are to be regarded with doubt.

When the eggs are pressed, after the method of Driesch, there is evidence that the place of formation of the micromeres is pre-determined, and not localized by intersection of the actual first and second planes of cleavage since it may be where the first and third furrows cross.

A repetition of Loeb's experiments[5] shows that the action of an increased strength of sodium-chlorid in the sea water is to stop not only the external but also the internal or nuclear phenomena of cleavage, contrary to Loeb's notion.

In the starfish *Asterias forbesii* it seems that shaking the eggs hastens the maturity processes!

The most remarkable part of the paper is the evidence pointing strongly to the conclusion that the eggs of the above star-fish may be fertilized by the sperm of the above sea-urchin, "two animals belonging to entirely different 'Classes' of the animal kingdom"!

In the second paper the vexed questions of the orientation of the embryo, the place and manner of closure of the blastopore and the related idea of concrescence are approached not only from direct study of living eggs but from the examination by sections and surface views of eggs that have been injured by needle-thrusts or modified, retarded, in development by action of certain salt solutions. Many important details hitherto overlooked are made plain and some interest-

[1] Edited by E. A. Andrews, Baltimore Md: to whom communications may be addressed.

[2] Anatomische Anzeiger IX.

[3] Quart. Journal Mic. Sci., Jan., 1894.

[4] See American Naturalist, March, 1893.

[5] See American Naturalist, April, 1893.

ing, but unsuccessful, experiments recorded in addition to these of immediate value. The general result is that the blastopore begins to form below the equator of the egg, in the white region, and closes in by a peculiar overgrowth from the dorsal lip, so that we cannot speak of a real process of concrescence of two lateral areas. The embryo is, however, formed along this region, that is upon what was the lower white side of the egg.

Embryology of Cyclascornea.—Heinrich Stauffacher has recently (Jen. Zeit., II Heft, 1893, pp. 196–246) studied in considerable detail the development and segmentation of the ova in *Cyclas cornea* L., in which the ova are developed in a single pair of follicles, the sperm in several pairs. The follicle is a simple tube lined with columar epitbelium, surrounded by a homogeneous membrane. The primitive ova first appear as small spherical or elliptical cells next the membrane, among the bases of the cells of the follicle. The nucleus occupies almost the whole cell and has its chromatin rather uniformly distributed in the form of granules. As the ovum grows, it projects into the cavity of the follicle beyond the surrounding cells, but remains attached to the membrane by a constantly narrowing stalk. The egg membrane is formed only over the free projecting portion; the point of the ovum by which it is last attached by the stalk, persists as the micropyle. The ovum grows in part by the absorption of the surrounding cells of the follicle. Two Centrosomes were found in the mature ovum.

Stauffacher's description of the earliest stages of segmentation does not differ widely from Ziegler's account (Zeit. Wiss. Zoöl., Vol. 41). The egg divides into a small primary micromere and a large macromere. The former divides into right and left secondary micromeres, the latter into a second primary micromere and a macromere. This process is repeated, new primary micromeres being formed from the same side of the macromere, so that in these early stages, the secondary micromeres are arranged as right and left rows lying on the macromere.

Bilateral symmetry is shown from the first. During the resting period after the formation of the first primary micromere, the protoplasm of the micromere with its nucleus, becomes arranged around its free periphery, leaving a considerable cavity in the micromere next the macromere. As the second, third and fourth primary micromeres are formed, a cavity is similarly found in each. It disappears from each as the next primary micromere is formed, and is not present after the fourth.

The true cleavage cavity appears in the 13-cell stage. In the 16-cell stage two mesenchyme cells were found lying in the cleavage cavity, near the macromere, and Stauffacher thinks they are derived from it.

At about the 30-cell stage the last primary micromere is formed. Ziegler thought it formed the two large primary mesoderm cells, but Stauffacher thinks it enters into the formation of the ectoderm along with all the previously formed micromeres.

The macromere next divides into equal right and left halves. From each of these a large cell is segmented off into the cleavage cavity, one slightly before the other, agreeing with Rabl's account for Unio. These two cells last formed are the primary mesoderm cells. The two small remaining macromeres form the endoderm.—C. P. SIGERFOOS.

ARCHEOLOGY AND ETHNOLOGY.

Progress of Field Work of the Department of American and Prehistoric Archeology of the University of Pennsylvania.—Further search for proof of Man's great antiquity in North America has led to an exploration, in November, 1893, of the chalk gorges in southern Texas, where rumor reported the discovery of human relics mixed with the bones of the Mammoth and Fossil Horse. But the alleged sites of artificial hornstone chips and of human interments examined in the San Diego gorge, (Duval County, Texas), belonged not to the fossil-bearing layers but to a talus, which, mingling modern surface loam with ancient underplaced chalk, has greatly obscured the record of the freshet-torn ravine.

Further negative evidence, again illustrating the difficulties to be encountered in the search for human relics in the ancient layers of these parched water courses, was found in the deeper gorge of Indian Creek, near Berclair, (Bee County, Texas), which, like that at San Diego, had in recent years furnished shelter and stagnant drinking water to roving Indian bands. Here artificial chips and fire-fractured stones falling from the loamy crest of a fossil-bearing bluff lay not far from the teeth of the extinct American Horse in an indiscriminate talus below, while the clear, water-eroded cuts, exposing for more than a mile the stratification, (chalk and pebbles, marl and sand 6 to 18 feet and surface loam 2 to 8 feet), showed no human relic in situ to prove that Man in southern Texas had ever been the contemporary of the Mammoth, the Broad-Horned Ox and the Fossil Horse.

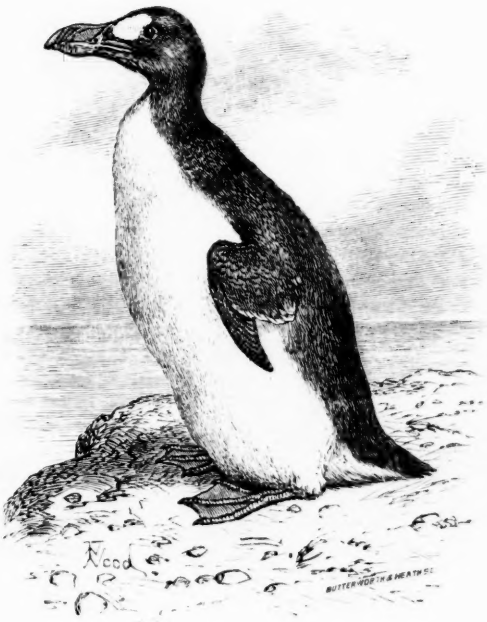
Turning again to the record of caves for the traces of Man as a possible predecessor of the Indian and contemporary of an older fauna in the Eastern United States, the dry, well-lit and easily accessible Cavern of Lookout Mountain, on the left Tennessee River bank, below Chattanooga, was examined in December, 1893. Four trenches, 6 feet wide and 5 feet 10 inches to 3 feet deep, dug twice to rock bottom across its floor, proved that Man had lived there. But they surprised us by showing the absence of distinct layers of occupancy separated by crusts of stalagmite, clay, sand or breccia, marking lapses of time between his comings and goings. Here, where the cave's shelter must have been forced upon the notice of primitive people by the narrowness of the river path and the height of the overhanging cliff, but a single bed of refuse, homogeneous throughout and showing no evolu-

tion in the form, material or grade of relics discovered, rested on the cave earth and limestone. No trace of "Paleolithic Man" or "Mound Builder," "Pigmy" or "Welshman" underlaid the familiar black band 3 feet 8 inches at thickest, that betrayed the well-known maker of shell-mixed pottery, bone awls, chert arrowheads, shell beads, drilled sandstone and clay pipes. The Indian, as known to the white discoverer, bringing with him a neolithic culture learned elsewhere, coming as high in the scale as he departed, and who had, as I found, laid the bones of his dead upon inner ledges of the cave and cast them dried and clean with arrowheads, potsherds, and broken perforated gorgets upon mortuary fires in a subterranean chasm 250 paces from the entrance, had alone inhabited the cave.

Paleontology would assert no antiquity for his occupancy as judged by the 29 living and 2 extinct species of fauna found with the refuse Some animals, traced by their bones in the fire places, like the Spade-Footed Toad, the Bat and the Tortoise, though the contemporaries or successors of the cave inhabitant, may have found their way into the midden heap to die, while the remains of the Unio, (7 species), Io, (2 species), Trypanostoma and Paludina, (2 species), and of the Catfish, Sucker, Drumfish, Land Tortoise, Water Tortoise, Soft-Shelled Turtle, Wild Turkey, Marmot, Lynx, Opossum, Squirrel, Raccoon, Otter and Deer, sometimes split and scorched, generally disassociated with teeth and but once showing traces of rodent gnawing, inferred the hunter's capture of food in river and forest and his carrying of larger animal trunks decapitated to the cave feast.

A bone of the extinct Peccary lying in the refuse repeated the discovery made in Queen Esther's chamber of Durham Cave, Pennsylvania. But the teeth of the Tapir (*Tapirus haysii*), and the lower ramus of an extinct Edentate of the family of Megatheriidæ kindly identified with all the other bones by Professor Cope, found by us in Section 5 (3rd foot) and close to the bottom of the layer of occupancy, added a new species and another genus to the list of (northwardly) extinct American mammals thus far observed in like association with human remains. Still we had not positively found that the Indian had met this gentle South Americanherbivore andan animal like the giant sloths Megalonyx or Mylodon, in the mountainous region of the upper Tennessee, for 1 foot 9 inches of the original red cave earth remained undisturbed and free from bones when examined, under the human refuse. The Tapir teeth and edentate jaw lying where found, near the bottom of the refuse and close to this lower stratum, may have been imbedded in the latter before the Indian came, so that if he

PLATE VIII.



Alca impennis L.

From The Dictionary of Birds.

encountered them in scratching his wonted oven hole he might have mixed them with what was to grow by degrees into the present fire-blackened layer.

The awe-inspiring entrance of the Nickajack Cave, (left bank of the Tennessee River, Marion County, Tennessee), though subject to partial invasion by river freshets that back the water of the cave creek several hundred yards into its channel, showed traces of aboriginal habitation as far as light penetrated. But the human refuse lay in a scattered talus on an uneven and craggy floor, about 250 feet wide, which, sloping steeply into the cave stream, was buried under masses of leached earth thrown upon it by nitre diggers in 1863–64. Where the remains of old fires were caught in hollows in the slanting ledge underlying this nitrous deposit, a trench (12 feet 10 inches long by 6 feet wide, by 2 feet 10 to 3 feet 5 inches deep), revealed again a single homogeneous layer of human occupancy continued on an undisturbed shelf clear of the nitre heaps and containing the remains of Unio (5 species), Paludina, Trypanostoma, fresh water Drumfish and Deer, and with its bone awls, arrowheads, chips, hammerstones and pottery repeating the record of the Lookout Cave. Again all trace of more ancient human presence betokened by underplaced deposits was wanting. Earlier peoples, if they existed, had avoided the Nickajack Cavern, and it is only pre-Columbian inhabitant had been the Neolithic Indian, who, strewing the alluvial meadows at its mouth with arrowheads and hornstone chips, had left potsherds, pebble hammers and a perforated ceremonial stone, along with the remains of the cave midden Mollusca and the Deer, Tortoise and Rabbit, at the river-side shell heaps a mile away.

Throughout the above investigation we have owed a grateful acknowledgement to the suggestion and kind encouragement and assistance of Professor Cope.—H. C. MERCER.

The Trenton Gravel Discussion has thrown light upon Man's antiquity in North America, but has not settled it.

We know that geologically, modern Indians chipped the rude leaf shaped outlines which we may as well call "Turtlebacks," but we do not yet know who else made them. The "Turtleback" exists without the Indian in Europe, and the more we study it the less—unhelped by associated evidence—we care to call it "Paleolith" or "Implement" on the one hand, or "Reject" "Unfinished Implement" or "Failure" on the other.

It was the quarry "Turtleback" of the pot making stone polishing Indian, that first fairly roused attention, and troubled us with the fear lest the Trenton "Turtlebacks" resembling it, had slipped down into the glacial gravels.

Some of the quarry "Turtlebacks" (viz., the spade like outlines from Garland Co., Arkansas), were big. Some (as the ½ inch long specimens from Macungie, Pa., and Flint Ridge, Ohio), were little. Some were made of pebbles (Piney Branch), some of native rock, some of Jasper, some (Gaddis' Run) of argillite, some were tolerably thinned before they left the quarry (Piney Branch and Flint Ridge). Others (Gaddis' Run) were not, some were leaf shaped, some rather triangular, others discoidal.

Still there was a family resemblance, and it seemed after examining thirteen American quarries east of the Rocky Mountains, that certain universal laws for blade chipping in the stone age had been discovered, for instance, that as the Indian quarrymen were yet Indians though they left no "Indian Relics" at the diggings, so the Drift Man (if he existed), though he left nothing but "Turtlebacks" in the Drift, might really have been a stone polisher and potter after all.

But to find arrowheads close by the pits at Flint Ridge, Macungie, and Saucon Creek, pitted hammerstones at Gaddis' Run, polished stone tools at Durham, and pointed wooden billets at Macungie, limited the ground for such inference, and as we may hope to find a rotting fuse or rusty iron drill under a heap of belgian blocks at a modern quarry, so there seems a chance of finding polished stone tools, arrowheads and pottery in the Drift, if the Drift Man made such things.

The fact that the Indians had quarried the stone, blocked it out into blade forms, rejected some of these, worked others into oft buried "blanks" and specialized the latter into spears and knives, seemed at first to indicate that an implement to be finished, and therefore to fairly represent the culture of its maker ought to be specialized. But the rule would not work always. The "Turtleback" was not the neglected brother of all chipped stone tools. What at Fort Bridger, Dakota, (as seen by Dr. Leidy in 1870) were serviceable implements (Teshoas) chipped by Indians from pebbles at a single blow, were at Washington quarry refuse chips. The flakes that were rubbish at Macungie and Flint Ridge, were hoarded together and carefully buried in Florida Mounds. If we went abroad we found in the Easter Island, knives, Admiralty Island, spears and Australian gum-mounted splinters, implements which were finished but yet unspecialized; and Mr. Ernest Volk showed us that "Turtleback" labelling might go wrong

at the very heart of the question where the ground seemed surest, when he found two hoards of rough argillite "Turtlebacks" which by all quarry experience ought to have been "rejects."

A whole new class of pros and cons were introduced into the study when we discovered in June at the argillite outcrop and indian blade quarry in the Delaware Valley, 20 miles above the hunting ground for the Trenton Turtlebacks; that there were two classes of Indian Turtlebacks—those of the quarry and those of the river-side. The evidence of these latter river-side specimens made from surface material, and that of Jasper pebbles found flaked by Indians at sea shore camp sites in New Jersey and Maryland, suggested strongly that "quarries" were comparatively modern and that rules of stone chipping derived therefrom would not cover the whole ground.

It seemed that the Indian must have been for a time a chipper of erratic stones on river beaches before the status of culture involved by quarries was reached, and that "Turtleback" work shops of what might be called a pre-quarry age, probably existed in the United States older than Flint Ridge, Durham, Gaddis' Run and Piney Branch, whose products remained to be compared with the alleged work in argillite of the Drift Man.

It was important to note that of the recorded argillite Trenton specimens, 29 were of this Delaware Indian "river-side" type, but against the case that one (Peabody Museum, No. 33,168, labelled as found 9 feet below the surface in the Penna. R. R. cut) had the stamp of the Gaddis' Run Indian quarry strongly upon it.—H. C. MERCER.

MICROSCOPY.[1]

Orienting Small Objects for Sectioning, and "Fixing" them, when Mounted in Cells.

I. In one of the recent "Contributions from the Zoological Laboratory of the Museum of Comp. Zoology," Vol. XXV, No. 3, Dr. W. McM. Woodworth describes a method of orienting small objects for the microtome. His method was developed, he states, from one first used by myself. To avoid any misunderstanding, I will say that in answer to a letter from my friend Dr. Woodworth, asking permission to use or describe my method, I replied that he was at liberty to make what use of it he saw fit, or words to that effect. I refer to the subject here, partly because Dr. Woodworth does not state what the original method was, or how he has modified or added to it, but mainly because I believe the original method is much simpler and better adapted to the purpose than his.

My method, which is especially useful when one desires to orient accurately large numbers of small and similar objects, is as follows:

Small strips of glazed writing paper marked with two sets of raised parallel lines running at right angles to each other are cut, and at suitable intervals a very small drop of thick collodion and clove oil, about the consistency of thick honey, is added. The drops are arranged close together along one of the ribs that run lengthwise of the paper. The object to be imbedded is cleared in clove oil, or oil of bergamot—not turpentine. The latter dries too quickly, so that air bubbles are likely to form in the object; and besides it does not mix readily, as it should, with the thick collodion. It is then raised on the point of a knife, and after the excess of oil is drawn off, transferred to a drop of the thick collodion. It may then be adjusted at leisure under the compound or the dissecting microscope, and will stay in any desired position.

When half a dozen or more objects are oriented in reference to the cross lines (which are to be parallel to the section planes) the whole thing is placed in turpentine. This washes out the clove oil and fixes the objects very firmly to the paper. When submerged in turpentine, if desirable, the relation of each object to the orienting lines can be redetermined under the compound microscope with greater precision than before. If any one of them has been inaccurately placed, it may still be moved to some extent, but it is better to note the fact, and

[1]Edited by C. O. Whitman, Chicago University.

make the necessary deviations from the section lines when that particular object is sectioned.

The paper with the attached objects is now placed in the paraffine bath, and finally removed and covered with paraffine in the usual way. After cooling in water, the block is trimmed and the softened paper peeled off, leaving the objects in the paraffine, close to the under surface of the block. This surface is now marked by the orienting lines of the ribbed paper and also by the record numbers, which, before imbedding, were written with a soft pencil on the paper. The block is now fixed in the microtome, and the objects cut one after the other, as though a single object had been imbedded; or a number of them may be cut together, if they have been arranged with that object in view. For example, we may use a thinner collodion, and arrange a large number of insect embryos, or small worms in a compact bundle, like a package of cigarettes, and cut them all at once.

Although I have not tried Dr. Woodworth's method, it seems to me that he has merely added to what is described above, several complications, which might in most cases be omitted. He gums the paper to a glass slide, dries it, covers the exposed surface first with a layer of gum and then with a collodion film, each of which must dry separately. The objects cleared in turpentine are then placed in position in the film which is softened and rendered adhesive by exposure to ether vapor, then slide and all are placed in the paraffine bath. Finally after imbedding, the slide is soaked in water to free it from the paper and the paper from the paraffine. In most cases I find it quite unnecessary to gum the paper, as it comes away from the collodion and the paraffine very well without it. It is, moreover, very inconvenient and unnecessary to imbed the paper attached to a glass slide in the paraffine bath. The paper alone can be handled with perfect ease, and it does not curl up or warp in the bath. If any warping occurs, I should say it was due, for obvious reasons, to the use of a collodion film in place of minute drops of collodion and clove oil. I should suppose also that any object of considerable size, say the egg of Limulus, could not be easily fixed in the manner suggested by Dr. Woodworth, for it is merely the adhesiveness of the small amount of turpentine on the object which must be depended upon to hold it in place. But as the turpentine evaporates rapidly, this would tend to free the object, or else fill it with air bubbles before the requisite number could be oriented, preparatory to softening the collodion in the ether vapor.

The advantages of the method, as I use it, are many; ease, rapidity (although we need not hurry) and accuracy of orientation; time saved

in imbedding and sectioning a considerable number of objects as one; and above all when many objects much alike are to be imbedded, there is no danger of confusion, since each one is plainly marked with its appropriate number.

* * * * * * * * * * * *

II. As every one knows, it is a great nuisance to mount under one cover, a large number of objects that tend to roll about into undesirable positions. It is often necessary to mount each one separately and then roll it about at great risk, till it is is just where we want it. And after all it is impossible to roll some things into place. I have used a modification of the method described above in mounting large numbers of objects under one cover, in perfect order, and in any desired position.

In mounting the eggs of Limulus, or heads of insect embryos, etc., I construct a cell of the requisite dimensions, and place in it small drops, close together in rows, of the thick collodion and clove oil. An egg is taken out of the clove oil, drained, and placed in a drop of collodion in the desired position. A great many eggs may thus be arranged like serial sections under one cover glass. Before adding the balsam, the slide is immersed in turpentine, which serves to wash away the clove oil and leave the eggs firmly fixed in the collodion.

The only precaution necessary is not to use too much collodion. It is surprising to find the small amount necessary, and the firmness with which the objects are held by it in place.

I have recently used, with a class of beginners, the above method of imbedding, with satisfactory results—merely as a matter of convenience in manipulating small objects easily soiled or broken in handling. Any glazed paper, or glazed tracing cloth will do, provided the collodion and clove oil is thick enough. The raised ribs may be replaced by fine black lines drawn with a soft pencil. These lines like the numbers are transferred to the paraffine when the paper is removed.

William Patten, Hanover, N. H.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Natural Science Association of Staten Island.—January 13.—The Secretary read an invitation to attend the funeral of the Rev. Samuel Lockwood, of Freehold, N. J. Also the following extract from a communication by Mr. Ira K. Morris, which was adopted as the sentiment of the meeting, ordered spread upon the minutes and a copy transmitted to the family of the deceased:

It is with profound sorrow that we learn of the death of Professor Samuel. Lockwood, of Freehold, N. J., on Tuesday last. By this sad event our Association has lost a very warm friend, and we shall feel most keenly the absence of his kindly encouragement and intelligent criticism. For years past he has taken a deep interest in all our proceedings.

Mr. Wm. T. Davis exhibited specimens of and read the following paper on Staten Island Harvest Flies.

Dr. Harris, writing of harvest flies, or locusts, in his "Insects Injurious to Vegetation," says of *Cicada canicularis* Harris:

"During many years in succession, with only one or two exceptions, I have heard this insect on the 25th of July for the first time in the season, drumming in the trees, on some part of the day between the hours of ten in the morning and two in the afternoon. It is true that all do not muster on the same day; for at first they are few in number, and scattered at great distances from each other; new-comers, however, are added from day to day, till in a short time, almost every tree seems to have its musician, and the rolling of their drums may be heard in every direction."

This *Cicada* is much less common on Staten Island than in Massachusetts, where Dr. Harris heard it sing so regularly on the 25th of July. It is plentiful, however, up the Hudson River, in northern New Jersey and in parts of Pennsylvania. On our Island its place is taken in point of numbers, by *Cicada tibicen* L., (*C. pruinosa* Say), a larger insect with a much more impetuous song. The species first appears about the second week of July, and I have recorded its song in the past as follows:

July 15, 1879, July 17, 1885, July 12, 1887, July 14, 1888, (three individuals), July 9, 1889, July 9, 1890, July 11, 1891, July 11, 1892.

Cicada tibicen L., also sings after dark on warm nights, but it is a lazy, languid song, as if the insect were tired, and it totally lacks the

impetuous vigor of the noon-day outburst. In the warm nights during the first part of August, 1887, it was no uncommon occurrence for this insect to give a short *z-ing*. Up to 8 p. m., they often sing, and I have heard a *Cicada* and a katy-did in adjoining trees. On Aug. 17, 1888, long after the sun was down, they kept up their songs, each one desiring apparently, to be the last singer, for their voices are raised in envy and the males have no love for one another. They often sing while flying about a tree in wavy lines, and once I detected another *Cicada* fly out of a tree and join the singer. It was no doubt a female.

They continue musical as late as the end of September, occasionally in considerable numbers I have heard them as late as October 3rd, both in 1885 and 1886. In the first mentioned year, they were exceedingly plentiful. When singing loudly the abdomen vibrates quite fast, but gradually lessens as the song subsides.

The dry pupa shells of this insect may be found attached to the bark of a variety of isolated trees, upon the roots of which the larvæ have apparently fed. On the 26th of July, 1889, at eighteen minutes to 5 p. m., I saw a harvest fly come from its pupa case. The legs (tarsi excepted) the prothorax and folded wings, were of a grass green color, the wings being particularly bright. The eyes were also green, the ocelli golden and the mesothorax and abdomen of a brassy appearance. In twenty minutes the wings were of full size, but flimsy, bending with the breeze. The wings were held out flat, on the same plane with the dorsal surface, when drying, and the genitalia are protruded.

The third and largest species of *Cicada* that has been found on the Island is *C. marginata* Say. The wings of a specimen, spread in the usual way, expand nearly five inches. This insect has also been taken at Yaphank, on Long Island, by Mr. A. C. Weeks; and Mr. Wm. H. Ashmead, who kindly examined my *Cicadas*, says that the insect occurs in Pennsylvania and about Washington. On our Island but one specimen has been found. It was discovered on a small post oak on a sand dune, near Mariners' Harbor, on July 19, 1892, while Mr. Beutenmuller and I were looking for galls. It was late in the afternoon and the insect had evidently but a short time before emerged from the pupa-case, which we found at the base of the tree. In the same summer a second pupa-shell was found on a black-jack oak, growing in dry sandy ground at Watchogue.

The only other harvest fly that has been collected on the Island is the red eyed periodical *Cicada*, or "Seventeen year Locust," of which a more detailed account, in connection with this locality, will be given at some future meeting.

Mr. Thos. Craig read a paper on A New Dictyosphærium.

In Wolle's description of this genus he describes the cells as green, and egg or kidney shaped, united in a globose hollow family, involved in a gelatinous integument.

He describes four species: *D. ehrenbergianum* Naeg., *D. pulchellum* Wood, *D. reniforme* Bulnh., and *D. hitchcockii* Wolle. The one under consideration does not agree in description with any of the above species. It was found along with other algae, tangled in the roots of water cress in a pond in the woods back of the Moravian Cemetery.

Mr. Walter C. Kerr exhibited a carefully prepared drawing of the trunk of a red maple tree and read a paper on Aerial Roots on *Acer rubrum, L.*

Near the brook flowing from Logan's spring swamp east of Silver Lake stands a red maple, about fourteen inches in diameter, and on its north side the bark has been stripped, probably by splitting from a wound received while young, forming a bare triangular space extending nearly across the base of the tree and having its apex thirty-six inches from the ground. The wounded bark has healed and its edges are covered with a smooth, gray, corky layer presenting the rounded appearance common to the edges of such scars. The wood being uninjured remains in a good state of preservation, while the entire tree is in vigorous growth.

It stands on a slight rise, about twenty-five feet south of the creek, in rich, rocky, moist ground, within eight feet of a low spot, which, though swampy in the wet seasons, is never overflowed.

The nearest trees are white oak and hop hornbeam, nine and fifteen feet distant, with no others within forty to fifty feet. Undergrowth is absent, and there is no reason to suppose that earth or stones have ever been heaped about it. It branches twenty feet from the ground and thus there are no conditions of darkness or exceptional moisture to encourage the development of aerial roots.

About six inches below and to the right of the apex of the triangular wound there springs from the cambium of the healed bark two roots, each one-half inch in diameter. They extend downward across the scar at an angle of about forty-five degrees; the upper being twelve inches and the lower seventeen inches long. They have decided root form and are covered with rootlets, the upper bearing about twenty and the lower about fifty.

The development of rootlets proceeds almost wholly from the lower surface of the roots, their length being from two to twelve inches, many being about six inches long, and all profusely branched, while

from the upper surface only a few stunted rootlets rise, sparsely branched. The whole appearance of these roots presents a strong contrast to the branches or young shoots of the red maple, leaving no doubt as to their character. Their tendency toward the earth is marked, though not reaching it by some eighteen inches.

What should cause these aerial roots is by no means evident, unless the scar has at some time been covered with a loose layer of bark under which the roots have grown. They serve no purpose and it would seem as though they could scarcely survive. As they are now alive, it seems best not to molest them for the purpose of determing their exact character and mode of growth until after further development has been observed.

Mr. Arthur Hollick presented specimens of fossil leaves from Arrochar.

Mr. L. P. Gratacap remarked upon a series of lower Helderberg and Hudson fossils, found in drift bowlders by Mr. Hollick at Arrochar. They included finely preserved specimens of *Spirifera perlamellosa* Hall; *Strophodonta beckii* Hall; *S. woolworthiana* Hall; *Strophomena rhomboidalis* Wahl.; *Cœlospira concava* Hall, and *Leptæna sericea* Sowerby, besides fragmentary remains of a *Pterinea* and bryozoöns.

Boston Society of Natural History.—February 7th.—The following paper was read: Prof. Edward B. Poulton: Theories of Evolution. A discussion upon the subject of Professor Poulton's paper followed.

February 21.—The following papers were read: Professor Charles R. Cross: Physics of color mixture, with experiments; Professor E. S. Morse: A recent advance in color printing by a photo-mechanical process.

SAMUEL HENSHAW, *Secretary.*

New York Academy of Sciences, Biological Section, Feb. 12.—The following papers were read: 1. "The Morphology and Significance of the Variations of the Biceps flexor cubiti," by Professor Geo. S. Huntington. 2. "Our Conception of a 'Species' as modified by the Theory of Evolution," by Professor N. L. Britton. 3. "Reversal of Cleavage in a Sinistral Gasteropod," by Mr. H. E. Crampton, Jr. 4. "On the History of the Archoplasm in the Spermatogenesis and Fertilization of Lumbricus," by Mr. Gary N. Calkins.

BASHFORD DEAN, *Rec. Sec.*

The Biological Society of Washington.—Feb. 10.—The following communications were read: Dr. C. Hart Merriam, A Remarkable New Rabbit from Mexico; Dr. C. W. Stiles, A Parasite of Man New to the American Fauna.

February 24.—The following communications were read: Mr. M. B. Waite, The Structure and Method of Opening of the Anthers of the Pomeæ; Mr. B. T. Galloway, The Winter Coloration of Evergreen Leaves; Mr. L. O. Howard, Further Notes on Spider Bites.

FREDERIC A. LUCAS, *Secretary.*

SCIENTIFIC NEWS.

From the Annual Report of the Essex Institute for 1893, we learn the following facts. The library has increased during the year by the addition of 3,317 volumes, 8,348 serials, and 7,416 pamphlets. These include the library of the late Dr. Henry Wheatland and the foreign exchanges of the Peabody Academy of Science, the libraries of the two institutions being now united. The total investments of the Institute now amount to $100,188.44, and the membership amounts to 325.

Giovanni Passerini, Professor of Botany in the University of Parma and well known for his studies on Aphides, died April 17, 1893.

Francis P. Pascoe, an English Coleopterist, died at Brighton, England, June 20, 1893, in his 80th year.

Dr. Robert Ritter von Schaub, who has studied the anatomy of the Mites, died in Vienna, Oct. 21, 1893.

Dr. A. K. Edward Baldamus, the ornithologist, died in Wolfenbüttel, Brunswick, Oct. 30, 1893, aged 81.

Robert Bentley, the botanist, died January, 1894. He was born at Hitchin, Herts, March 25, 1821. For many years he was professor of botany in the London Institution and examiner in botany to the Royal College of Veterinary Surgeons of England; lecturer on botany at at the medical colleges of the London, Middlesex and St. Mary's

Hospitals, and for twenty years dean of the medical faculty in King's College, London. For ten years he was one of the editors of the Pharmaceutical Journal. He wrote a "Manual of Botany," which has reached the fifth edition. He was the author of a series of manuals of elementary science, also "Student's Guide to Structural, Morphological and Physiological Botany." And was the joint author with Dr. Trimen, of a four-volume illustrated work on "Medicinal Plants."

Mr. E. B. Poulton, who has recently been lecturing in various cities of the United States, has been elected Hope Professor of Entomology in the University of Oxford, as successor to the late John Obadiah Westwood.

The summer school of Cornell University announces courses in Physical Geography, Geology and Economic Geology, by Professor R. S. Tarr.

The following appointments have been made at Cornell University. here. Mr. G. D. Harris, Assist. Professor of Paleontology and Dr. A. C. Gill, Assist. Professor of Mineralogy and Petrography.